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Diesel Engines and Transmissions for Railroad Service*

By A. I. Lipetz†

A discussion of the principles of Diesel engine operation, the characteristics of some of the well-known types of engines in transportation service in this country and Europe and a classification of power transmission systems

THE modern Diesel engine cycle is best understood from the pressure-volume indicator card of the constant-pressure four-stroke cycle. It is assumed that this is known and, therefore, is not referred to here. Its closest approximation is now found only in air-injection engines. The thermal efficiency of this cycle depends upon the compression ratio. When it is 13 the theoretical thermal efficiency is .572; but in a real Diesel engine there are a number of deviations from an ideal cycle; the various valve events do not take place as assumed in the ideal engine. This, with water-jacket losses and consequences of improper combustion, reduces the total efficiency of a real air-injection Diesel engine to about .33.

The Diesel engine with air injection was used extensively before the war and in the early part of the post-war period. At present practically all Diesel engines, even of the slow-speed and large-size type, especially the high-speed engines used in land transportation in which we are here interested, are of airless injection, or compressorless types, also called solid- or direct-injection-type engines. Dr. Diesel in the early period of developing this engine started out with the idea of the direct injection of oil, but encountered great difficulties. He could not get, at the stage of the art of that time, the high oil pressures that were necessary. Air injection was resorted to by Dr. Diesel as a remedy to avoid the difficulty. However, during the war, the English firm, Messrs. Vickers, Ltd., took up the question again and did a great deal of research work. Commander Professor Hawkes did most of the work and later published his investigations.[1] After the war various firms in England, Germany, and other European countries, and later also in the United States, conducted similar experiments and achieved very good results. At the present time direct fuel injection is universal in Diesel engines and air-injection engines are very seldom built, even in large sizes.

The process which takes place in an airless injection engine is the following: Fuel oil under very high pressure, ordinarily 3,500 to 6,000 lb. per sq. in., in passing through the small openings of the fuel nozzle, atomizes into a very fine mist which penetrates into the densely compressed and heated air slightly before the moment the piston reaches the dead-center extreme position. The nearest droplets ignite and create a nucleus of flame, which propagates with great rapidity and sets on fire the whole mixture in the combustion chamber between the piston and cylinder head. Preliminary turbulence of air and oil is essential, because it is necessary in a very short time—a small particle of a second—to complete the combustion. This requires a very intimate mixing of the globules of the oil mist with the air and, therefore, a quick motion of the air in the direction opposite, or at an angle, to the fuel jet is very helpful. The rapid movement of the piston, while it approaches the cylinder head, creates this motion if the proper shape is given to the piston head. In some cases a whirling motion in addition is obtained, and this is also very useful. It has been found that the ordinary flat head and slightly dished piston are quite sufficient for some powers and speeds, but do not give good combustion at high speed. In another case, powers up to 100 b.hp. per cylinder are smokelessly generated at 700 r.p.m. with a flat cylinder head and a half-spherical piston head. In still another

[1] "Some Experiments in Connection with the Injection and Combustion of Fuel-Oil in Diesel Engines," by Engineer Commander C. J. Hawkes, a paper read before the North East Coast Institution of Engineers and Shipbuilders on November 26, 1920.

* Extract from Engineering Bulletin, Research Series No. 49, published by Purdue University, Lafayette, Ind. The complete bulletin, as issued under date of March, 1935, contains five sections, as follows: I—Historical Notes; II—The Diesel Engine; III—Power Transmissions; IV—Diesel Propelled Locomotives and Cars—Potentialities, and V—The Possibilities of the Diesel Locomotive. This article is an abstract of Sections II and III.

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case similarly good, if not better, results are achieved with a cylindrical boss and a corresponding recess in the head.

By experience a certain shape always can be found that will give satisfactory combustion with direct injection practically for any power. Now solid-injection engines are built of 1,000 b.hp. and greater per one single-acting cylinder.

Advantages of Solid Injection

The great advantage of the solid-injection system lies in the elimination of the compressor, which is a very delicate mechanism that requires much maintenance and expert attention. Sometimes it is a source of trouble, as it can not run reliably at high speeds. It is a complication and its elimination represents enormous progress. In addition, the fuel consumption is lower because the power to drive the compressor is saved. The total net gain by using the solid-injection system is from six to eight per cent.

Strictly speaking, the constant-pressure cycle, which has been always considered to be the basis of the Diesel engine, does not materialize in modern solid-injection engines. Instead of the constant-pressure cycle with a maximum pressure equal to the compression pressure of the second stroke, a slightly different cycle with a variable pressure during the ignition period is actually developed. It approximates the ideal diagram as shown in Fig. 1 by line *b-c-d-e-g-b,* which is a combination of a constant-pressure and a constant-volume cycle. It is called a "mixed," or "dual" cycle, and is also known as the Sabathé cycle. Heat Q_1 and Q_2 are being imparted during the constant-volume (ignition) period *c-d* and constant-pressure, (burning) period *d-e*. Heat Q_3 is rejected as in the constant-pressure cycle. The efficiency of such a cycle is higher than that of the constant-pressure cycle with the same compression ratio, because the maximum pressure is higher.

Solid injection brought about another development—increase in speed. The fact that the cycle is not exactly a constant-pressure cycle and embodies partly the explosion-cycle feature permits the completion of the burning of the requisite amount of fuel in a very short time and thus the running of the engine at higher speed with equally good combustion. When air is used for the pulverization of fuel and is gradually introduced, there is not such a quick ignition and burning as in the explosion engine. Therefore, in the modern solid-injection engine, which has the quick burning feature of the explosion engine, the speed can be materially increased. Piston speeds of 1,800 to 2,100 ft. per min. are no longer impossible and even higher speeds have already been attained experimentally.

It can be easily gathered from the above that the most important part of the solid-injection engine is the fuel-injection mechanism. Like everything else in engineering development, it has gone through a certain process of evolution and has finally settled down to a very simple and definite form. This mechanism consists of two essential parts—the fuel injection pump and the fuel spray nozzle. For high-speed engines, as used in Diesels for transportation purposes, the most often found combination is the individual plunger pump with a pressure-operated spray nozzle. The pump has as many plungers as there are cylinders, each plunger having a constant stroke and delivering oil under pressure to the corresponding cylinder. The fuel nozzle is inserted through the cylinder head, or cylinder wall, directly into the combustion chamber and is terminated by a tip with one or more very small orifices for oil discharge. The admission of the fuel to the tip is controlled by a spring-loaded needle valve which opens when the fuel pressure is able to compress the spring and lift the needle. The injection is due to the oil pressure created by the pump plunger, the beginning of the discharge being coincident with the opening of the needle, while the termination is due to the sudden release of the pressure. For this purpose a special spilling, or by-pass, valve is used which permits the direction of the excess oil from the oil delivery chamber back to the suction chamber of the pump. The by-pass is under control of a governor, and if the governor is also of the variable-speed type, the output of the engine and the variation in speed are easily controlled.

The importance of these parts—fuel pump, fuel nozzle and governor—can be judged by the following: In a medium-sized, four-cycle Diesel engine developing about 100 b.hp. per cylinder at 700 r.p.m., the amount of fuel oil injected in a cylinder per working stroke is about .03 oz., or about 27 drops. This amount must be metered by the pump with an accuracy of one-half of

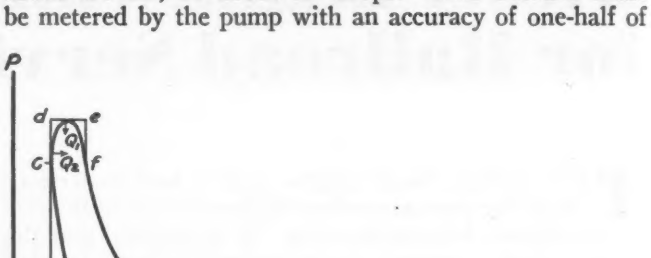


Fig. 1—Dual compression-ignition cycle-pressure-volume diagram

one per cent, or slightly more, depending upon the sensitiveness of the governor. This small quantity of fuel has to be delivered through the spray nozzle within less than one-hundredth (.0076) of a second and then it should be sharply cut off so as to avoid dribbling which may cause after-burning and smoke. This all indicates that the spray valve, fuel pump, and governor must be exceptionally accurate mechanisms. In small Maybach Diesel engines, running at 1,400 r.p.m., which are used in rail cars and also in airship and some aeroplane solid-injection engines, the amount of fuel per working stroke is only 3½ drops and the injection period is 1/156 sec. Upon the accuracy, reliability and sensitiveness of these appliances depend the quality of the engine, its economy, smokelessness, smoothness of operation, endurance and low maintenance cost, or, to put it in two words, its practicability and its commercial success.

The volume-pressure diagram above referred to (Fig. 1) pertains to four-cycle engines. The majority of engines built in this country for railroad service are of this type. The Ingersoll-Rand, the Beardmore-Westinghouse, the McIntosh & Seymour, the Cummins engines are all of the four-cycle type. The same is true of engines abroad—M.A.N., Armstrong-Sulzer, Maybach, etc.

The four-cycle engines have the advantage that for the expelling of the burned gases and for the intake of fresh air two complete strokes are provided. This insures the thoroughness of the operations. In other

words, in a four-cycle engine the cylinder is thoroughly cleaned of burned gases and again refilled, almost to its full volume, with fresh air. This results in good combustion and high mean effective pressure and also permits high piston and rotative speeds.

Four- and Two-Cycle Engines

However, in 1878, before the advent of the Diesel engine, Dugald Clerk, later Sir Dugald Clerk, built a gas engine in which the exhaust and suction strokes were omitted and part of the compression stroke was utilized for the exhaust and expelling of gases. In order to achieve this a special pump had to be used which generated compressed air under some rather low pressure, which air was used for the expelling of the burned gases and for the charging of the cylinder with fresh air. The main object of the pump was to scavenge the cylinder and it was, therefore, called "scavenging pump." The four-stroke cycle was thus modified into a two-stroke cycle and the engines that followed were called "two-stroke" or two-cycle engines.

The Diesel engine, shortly after its appearance, was built both in the four-cycle and two-cycle types. The evident advantage of the two-cycle engine is that for the same piston and rotative speed the number of working strokes is double that of the four-cycle engine and, thus with the same mean effective pressure, the power of the engine should be doubled. Experience, however, proved that the mean effective pressure of a two-cycle engine can be made equal to that of a four-cycle engine only when the method of scavenging is sufficiently thorough to permit perfect combustion, and this in turn with some systems of scavenging is rather difficult at high speeds, as there is not sufficient time for the scavenging air to expel the gases and fill the cylinders with fresh air. This spurred a long and very important research which led to the development of a series of systems of scavenging.

The best system of scavenging is the straight-through arrangement by which the scavenging air is admitted at one end of the cylinder and permitted to escape at the other end, sweeping out the burned gases on its path through the cylinder. The opposed-piston engine, in the development of which the late Professor Junkers was instrumental during the last 28 years, is the best example of such an arrangement. The engine must thus have a double number of pistons and two crankshafts and becomes more complicated. On the other hand, this complication permits good scavenging, complete combustion, high mean effective pressures, and high piston speeds, resulting in high power per unit of weight. Engines of this type are not cheap to manufacture and have not been used to any extent in rail transportation. So far, a small 300 b.hp. opposed-piston engine at 1,200 r.p.m., built by Fairbanks, Morse & Co., Beloit, Wis., has been recently installed in a rail car of the Chicago, Milwaukee & St. Paul and one was put in an experimental 1,000 b.hp. direct-drive locomotive built by the Ansaldo Engine Company in Italy in 1926.[2]

The firm of Burmeister and Wain of Copenhagen has developed a modified opposed-piston two-cycle engine in which the upper piston is made considerably smaller and acts as a piston valve for the exhaust of gases and of the scavenging air. The air enters through a ring of ports at the bottom of the cylinder and escapes with the gases through the upper small ports controlled by the piston valve. The Winton Engine Company, a subsidiary of General Motors Corporation in this country, has developed a similar engine in which four exhaust valves of the regular mushroom type take the place of the piston valve of the Burmeister and Wain engine. In the Winton engine they are placed in the top cylinder head, and thus the straight-through scavenging principle from the bottom to the top of the cylinder is assured. The latter engine has become very prominent lately in view of its light weight, which is only 22 lb. per horsepower. It has, therefore, been used in the recent light-weight, high-speed trains to which reference will be made later.

Characteristics of Rail-Service Engines

The four-cycle engines are ordinarily heavier—from 25 to 63 lb. per horsepower, depending upon the service of the locomotive for which the engine is intended. In switching service, where practically all the four-cycle engines are used, an excess of weight is very desirable, because weight is wanted for adhesion on drivers and for the realization of larger tractive forces. Besides, the heavier engines allow a more robust and durable construction, which requires less maintenance and depreciation. When the service requires lighter engines the four-cycle engine is designed and built accordingly and, if necessary, speeded up. For instance, the 600 b.hp. at 700 r.p.m. McIntosh & Seymour four-cycle engine, which for switching locomotives is built so as to weigh 59 lb. per horsepower, when used for the light-weight, high-speed train of the Gulf, Mobile & Northern, weighs only 39 lb. per horsepower. The Beardmore four-cycle, 900 r.p.m. engines, which have been used in many rail cars and in one road locomotive in Canada, weigh from 17 to 22 lb. per horsepower. The Westinghouse-Beardmore engines for rail cars and locomotives in this country are now slightly heavier; they have been increased in size of cylinders, as compared with the Beardmore engines for the Canadian rail cars, and weigh about 30 lb. per horsepower. The Maybach four-cycle engines used in great numbers in rail cars and articulated high-speed trains in Europe run at 1,300 to 1,400 r.p.m. and weigh only 10.8 to 13.9 lb. per horsepower. The power of these engines varies from 180 to 410 b.hp.

There are a number of smaller four cycle engines in use in rail cars in Europe, some of them as small as 65 b.hp., but the lightest per horsepower is the Maybach engine above referred to, developed primarily for airship (dirigible) service in Germany. The piston speed of the largest Maybach engine, which is 410 b.hp. unsupercharged and 600 b.hp. supercharged, is 1,654 ft. per min. In the large Beardmore four-cycle engine for the Canadian National locomotive developing 111 b.hp. per cylinder (1,330 b.hp. in 12 cylinders) the stroke is 12 in. and, as the rotative speed is 800 r.p.m., the piston speed is 1,600 ft. per min., about the same as in the light Maybach engine.

An engine which is now becoming very popular for rail cars in Europe is the Hungarian Ganz with a pre-combustion chamber of the Jnedrassik type. This engine develops 400 b. hp. at 1,450 r.p.m., corresponding to a piston speed of 2,090 ft. per min. Its weight is 16 lb. per horsepower.

Thus the question whether the two-cycle engine can develop more power per unit of weight and volume is still an open question which will be decided only by actual trial and all-around service experience regarding cost, operation, maintenance and durability.

Besides the Winton two-cycle engine, which develops 75 hp. per cylinder at 720 r.p.m. Busch-Sulzer of St. Louis built a 1,600 hp., two-cycle engine in eight V-type cylinders of 13½ in. in diameter and 16 in. stroke (200 b.hp. per cylinder) at 550 r.p.m., which is the largest one-unit Diesel engine built for railroad use in this

[2] The Locomotive, March 14, 1931, page 73.

country. Still larger two-cycle Diesel engines are being developed by the same company for locomotives in larger numbers of cylinders of the same size—a 2,000-b.hp. engine, according to rumors, is being built in ten cylinders, and a 3,500-b.hp. engine in sixteen cylinders at 600 r.p.m. is now being offered. All these engines are of the V-type and weigh between 22 and 25 lb. per b.hp.

In Europe the two-cycle engine has not made much progress, either for locomotives or rail cars. The Burmeister and Wain Company in Copenhagen, and their licensees in England, built several engines of 200, 450 and 600 b.hp. The firm of Sulzer Brothers in Winterthur, Switzerland, is building for locomotives only four-cycle engines of about 100 b.hp. per cylinder at 630 to 720 r.p.m. The same engine is being built by Armstrong, Whitworth & Company. They are known as Armstrong-Sulzer engines. The largest engines of this type were built in eight-cylinder units by Armstrong, Whitworth in Great Britain for South America, Russia, and Algeria. Other large engines for railroad use were built by M.A.N., and by their licensees, for the French P.L.M. railroad for high-speed passenger service. A 2,000-hp. supercharged one unit four-cycle engine is, it is rumored, being built by Sulzer Brothers for the same French railroad for road service. A 1,000-b.hp. four-cycle engine was built by another Danish firm, Frichs, for Siam. There are about a score of locomotives in Siam with Frichs engines of different powers up to 1,600 b.hp.

The transmission of power, as it has been stated before, is indispensable in any Diesel-propelled vehicle. In a paper presented before the American Society of Mechanical Engineers[3] all possible transmissions were classified and reviewed. The classifications were as follows:

A. Full-power Elastic Fluid Transmissions. To this belonged the well-known electric transmission, which has already been in use for a long time, and the hydraulic, steam, and aero-steam transmissions which for some time have been either experimented with or suggested for experimentation. None of the various systems, except the electric, proved to be practicable, even for small powers, while the electric has made progress with various types of control (automatic, differential, Lemp), torque control (Westinghouse) and speed control, in which later control considerable improvement has been made lately. At present the electric transmission is predominating for powers above 150 hp. per unit. For smaller powers the gear transmissions with clutches are used, except in one or two cases, when gears with magnetically operated friction clutches are also experimentally used in powers of 600 to 1,200 b.hp.—a few words about these gear transmissions will be said later.

Quite recently a number of hydraulic transmissions of the turbine-wheel type have been revived, first for pleasure cars under the name fluid fly wheel, and later for rail cars under various names. None has made real progress for rail transportation, except one known as the Voith transmission which is being used in Europe for rail cars and light-weight trains for power up to 410 hp. per unit Its use for 600 hp. and even larger power is now being contemplated.[4]

B. Differential Elastic Fluid Transmissions, which could also be of the electric, hydraulic, pneumatic, and mechanical variety. The attractive feature of all these transmissions was that only at starting and low speeds is a considerable amount of power transmitted indirectly, with the efficiencies of Class *A* transmissions, while at higher speeds the major part of the power is transmitted directly with a much higher efficiency. At top speed the whole power is transmitted directly with an efficiency of about 93 per cent. Great ingenuity has been displayed in some of the transmissions of this class, and many new devices are still being invented and patented. Some of these transmissions have been built and tested, but none has proved practicable for large power. For small power, when they were developed with a view to use in automobiles, they worked more or less satisfactorily, but for this purpose they are not needed, as the shifting of gears is not yet considered to be objectionable. They may come, though, later, but so far they have not made much progress.

C. Mechanical and Direct Transmission. For rail cars and small locomotives up to 150 hp. the mechanical transmission has the advantage of cheapness and higher efficiency. Sometimes epicyclic gears are used in conjunction with clutches. By selecting the proper clutches the different speeds can be obtained. In other cases ordinary gears, which are always in mesh, are used, and by means of selective clutches put in operation, one at a time, the proper pair of gears is engaged. The clutches are always of the friction type, actuated hydraulically (S.L.M. Winterthur type), pneumatically (Fiat, Breda or Somua), or magnetically (Eisenach-Krupp).

Transmissions of these types have been tried out in locomotives and cars. The one that attracted much attention in the railroad field was the Eisenach-Krupp magnetic clutch and nytralloy-gear combination of the Russian Diesel-geared 4-10-2 locomotive, built by Hohenzollern Locomotive Works of Dusseldorf, Germany, in 1926. About a year ago a 600-b.hp. locomotive with gears and Eisenach magnetic clutches was built by Krupp for Japan. In this locomotive the main magnetic clutch was replaced by a specially developed hydraulic clutch.

RAIL ODDITIES

by MARINAC

For explanation see page 486

[3] Transmission of Power on Oil-Engine Locomotives, by A. I. Lipetz, Mechanical Engineering, August and September, 1926.

[4] Diesel Railway Traction, supplement to the Railway Gazette, May 18, 1934, page 919.

High Spots in Correspondence with Enginehouse Foremen*

Additional comments on the "Roundhouse Foreman's Daily Log", published in May, 1935

"WE have read with some little amusement the roundhouse foreman's letter published in the May issue of the *Railway Mechanical Engineer,* and took pleasure in reading it at one of our foremen's meetings.

"His statement that a 12-hour job is no sinecure is certainly true. We believe shorter working hours would not only be a benefit to the employee, but also to the employer. However, the outlook does not seem quite as bad as indicated in the letter. This is a fair-sized enginehouse and we still manage to enjoy the work and have plenty of laughs. There is no doubt but that the people one works for have considerable to do with the outlook on the problems that develop and we are very fortunate in this respect. Our superiors are always thought of with respect and regarded with a real liking and are always willing to work with us.

"The foreman is responsible for some of the conditions he cites. It seems as though more organizing would help relieve him of some of the work and take a load off his shoulders.

"As to shortage of power, trying to fill orders on time, the pride in doing good work and keeping personal contact with everything, these conditions exist everywhere. These things make roundhouse work interesting; in fact, I doubt if you would be successful in chasing any 'dyed-in-the-wool' roundhouse man out of the roundhouse."

Tired but Cheerful

"I read the 'Roundhouse Foreman's Daily Log,' " says another writer, "with a great deal of interest and must say that he described his duties and troubles without any over-statement of facts. The foremen here have one big advantage as we are on an eight-hour day; I do not see how a man can hold up for any length of time on a 12-hour day under present conditions.

"The roundhouse foremen are the only foremen at this terminal; they have to cover a great deal of ground in supervising about 40 men, scattered in the different departments. The foreman and the yardmaster have between them a caller and clerk (one person), so he does not get a great deal of assistance there. When the reports and roundhouse book are to be written up for the next shift the clerk is generally calling a crew or is attending to the yard office, while the yardmaster is checking the yard.

"In addition to this the storehouse stock has been cut so fine that when he writes a requisition for a rod bushing or any material of that kind he pays a visit to the storehouse, calling the storekeeper's attention to it so it can be replaced.

"At least once a month we get a letter to watch expenses and to make any further reductions we can in the force. In spite of all this and the fact that we go home tired we are still cheerful most of the time and do not want to get out of the game."

From an Ex-Roundhouse Foreman

"As I am now an ex-roundhouse foreman, I feel at liberty to air some of the trials and tribulations that this class of railroad employee must contend with. Every statement your correspondent made is true and typical of what 90 per cent of his brothers have to put up with.

"My day started by getting out of bed at 5.00 a.m., just about as tired as when I retired the night before. On the job by 6.30 a.m. I will not bore you with what had to be done; suffice it to say that it is a continual race against time. You work 12 to 14 hours a day, but still the day is not long enough to finish up the work you have set out to do, because of the obstacles you encounter and those which are thrown in your way. Your main difficulty is lack of men and material. You just manage to keep your head above water, barely swimming. Sometimes you are swamped, but by superhuman effort you come out on top again.

"It is the foreman in the medium sized shop of around a hundred men and twenty to thirty engines who has the toughest time, as he is in sole charge with no other foreman with him. He takes care of the various crafts and laborers; in fact, is responsible for the whole plant. Engine dispatching is his side line, sandwiched in with his other duties. He does his own clerical work, and when all is said and done has a pretty busy time. It all boils down to this objective; he must condition his engines with the expenditure of the least possible man-hours per engine; and a minimum of repair parts, and in such a way that they will haul with safety the maximum revenue ton-miles per minimum expenditure for coal, water and oil. Yes, this is all worked out at headquarters and a graph shows instantly whether he is slipping or not.

"My day used to end anywhere between 6.30 p.m. and midnight, depending upon weather conditions and the situation in general.

"I do not want you to get the impression that I did not care for my job as foreman. Maybe we love our jobs and our men too well, if not wisely. I would not have given it up. It was something of a shock to have the job done away with, but what a relief to work only 40 hours a week, instead of the 90 to 100 formerly worked. I am not tired out any more and I get some enjoyment out of life. I am renewing acquaintances that have been broken for the past 10 years. I do not think that I would take such a job again if it were offered to me. Life is too short and sweet, but when I die I hope that the Good Lord has prepared a special Heaven for the present and past roundhouse foremen. He has had his Hell on earth. No, we do not ask that there be no locomotives there; in fact, we want engines that must have work done on them, but give us an abundance of men, material and time to put them in 100 per cent shape to travel the golden rails."

* Other comments will be found in the June number, page 241; August, page 333; September, page 386; October, pages 423 and 432.

Equipment Dismantling Plant for C. M. St. P. & P.

Scrapping of cars and locomotives for entire system now concentrated at Dubuque, Iowa—Retirement plans provide for continuous operation for a long period of time

DURING the past year the Chicago, Milwaukee, St. Paul & Pacific has been carrying on an extensive car and locomotive dismantling operation at Dubuque, Iowa, where 150 machinists, boiler workers, car men and other employees are engaged in destroying cars and locomotives sent there from all points on the system. Under the program 8,537 freight, work and passenger cars and 421 locomotives were authorized to be dismantled in 1934 and 1935 and it is anticipated that approximately 2,500 cars will be handled in the same manner annually during the next five years. Thus far, 3,500 cars and 121 locomotives have been dismantled at the plant, the rate at present being 12 cars and one or more locomotives per day.

The establishment of the plant is the last step in a program which has been under consideration since 1931 and has had as its objective the orderly retirement of freight cars which have become obsolete or which can no longer be maintained economically. As early as 1928 a study was made of every type of car owned and, with the aid of cost records, schedules were prepared which prescribe a limit on the amount which may be expended to continue each car in service and which provide that, when this allotment will be exceeded in repairing any of the cars in question, it will be withdrawn from revenue service.

The Dubuque shop was selected as a place reasonbly close to the scrap market where the work could be carried on without interfering with other work and without requiring extensive additions or rearrangements of facilities, and also where the dismantling could be performed effectively by former employees. While situated on a secondary line, Dubuque is within a few miles of a junction with two main lines and also at a point where it is necessary to maintain switch engines for other purposes.

Facilities Provided

The facilities consist of an old tank repair shop, 75 ft. wide and 170 ft. long, containing 9 tracks; an old coach shop of the same size, containing 10 tracks; a transfer table serving these two shops and 20 or more tracks, half of them running parallel to the main line where they were once laid to serve the shops, and the balance following the river bank where they were once laid for storing cars. The land between the two sets of tracks was cleared of old sheds, cross-overs were installed in the dismantling tracks, and a new building was constructed for generating acetylene and distributing oxygen and acetylene to outlets installed throughout the yard.

This oxyacetylene plant, designed by the Air Reduction Sales Company, is one of the largest in use on a railroad. It consists of a brick and concrete building 26 ft. wide and 50 ft. long, with one room containing two Airco oxygen manifolds, each holding 20 cylinders for a combined production of 30,000 cu. ft. of oxygen per day under 35-lb. pressure, a second room for storing carbide, and the third containing three Airco-DB actylene generators holding 300 lb. of carbide each. This building has a concrete floor, metal doors, and each a corrugated steel roof, vapor-proof lights, ventilators in the room and at floor level, and has a shipping platform carfloor high on one side.

The facilities provided include trays for collecting and shipping material by means of power units which handle the material around the plant. A steam wrecking crane is available for use in the boiler and dismantling yard for loading uncut boilers or performing other heavy work. Apparatus has been installed for removing tires and re-

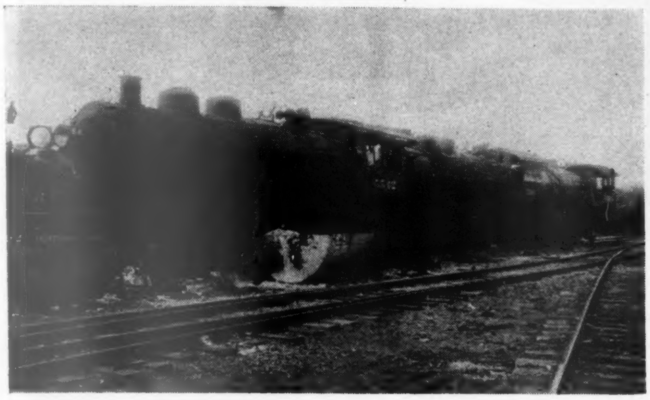
Cutting up underframes and center sills is an important part of the work in the North Shop

covering the lead in the counterbalances of wheel centers.

The program for 1935 provides for the retirement of 2,185 freight cars, as follows:

Series	Average age	Owned of type to be dismantled	Ordered retired	Construction
Automobile	24	1,019	210	Steel underframe
Ballast	22	606	65	Steel underframe
Box	25	14,158	1,060	Steel underframe
Caboose	35	833	10	Steel center sill
Flat	26	2,690	305	Wood and steel
Gondola	25	2,756	375	Steel underframe
Ore	24	574	80	Wood
Stock	29	322	40	Wood and steel
Hopper	22	114	40	All-steel
Totals		23,072	2,185	

When cars of these series require repair work and it is found that the estimated repairs exceed the maximum manhour expenditure allowable per car, they are set aside



Locomotives waiting to be scrapped

for dismantling and are forwarded to Dubuque as called for. The trucks under the cars vary from arch-bar types to T- and U- section side frames and, since the box cars are principally of the double-sheathed type with nails closely spaced, they are burned, except for a few bodies which are requested by employees desiring to strip them for kindling wood and a few sold to local buyers.

Method of Scrapping Box Cars

Box cars are brought into the burning yard each night by switch engines and spotted in blocks of eight cars each on the three tracks next to the burning yard, where six cutters with oxyacetylene torches cut the bodies loose from the underframes and one cutter separates the metal roofs, which are saved. The locomotive crane, moving under its own power, switches eight cars at a time to the track next to the burning yard and then from the adjacent track, tips the cars, one at a time, into the burning field, and rolls them over until 16 cars are ready

Interior of the oxy-acetylene plant designed by the Air Reduction Sales Company—the plant includes two Airco manifolds and 20 oxygen cylinders

for burning. Two laborers work with the crane in this operation.

Having completed this operation by noon, the cars are ignited and burn until about 2:30 p.m., when the remaining 16 cars are dumped in the same place and ignited after work has stopped for the day. The following morning the scrap is sufficiently cool to enable the crew to cut and load it, the practice being to use one end of the burning field one day and the other the next day, so that crews can be employed continuously in cutting up the scrap and in burning the equipment.

The scrap is reduced to No. 1 melting steel, or in sizes not to exceed 18 in. in width and 5 ft. in length, by a crew consisting of 10 regular cutters, who are assisted by the seven other cutters when the latter are not cutting the bodies of cars from the underframes. Ten laborers gather the cut scrap into piles ready for loading. The

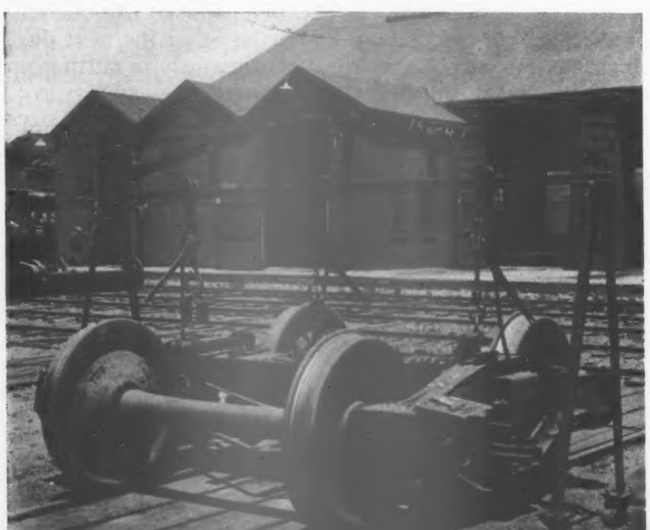
After the boiler has been removed the cylinders, running gear and driving wheels are dismantled

crane uses a magnet in this operation and moves the loaded cars to a point from which they can be switched out at night. During the same night the frames on their own trucks are switched to a track accessible to the dismantling shops.

The second stage of the dismantling is carried out in the old tank shop, now called the North shop, which has nine transverse tracks and a well preserved floor. Numbered from one end of the shop to the other, the first track is used for spotting an empty scrap car, the second is a dead track over which two underframes are placed, the third is used to receive the underframes to be dismantled, the fourth is another dead track for cutting two underframes, the fifth holds another empty scrap car, the sixth is another dead track for cutting underframes, the seventh is another live track for receiving underframes, the eighth is another dead track for cutting underframes, and the ninth holds another scrap car. Working on a schedule of 32 cars per day, this shop is operated on two shifts, each shift consisting of two gangs of five cutters and four laborers.

An Underframe an Hour

When the shop is ready for additional frames the transfer table operator and a laborer proceed to the storage track, pull one of the mounted frames onto the transfer table, and move it to one of the two receiving tracks in the shop. A high-lift truck, using a hook, then pulls the frame into the shop. The same truck is then placed under the center of the underframe (the two needle beams in the center having been cut off in the burning yard to permit this operation) and the frame is lifted off its trucks and placed to one side on stilts. The lift truck then returns the car trucks to the transfer table for dismantling in the South shop. A second underframe is then deposited next to the first and the cutters, having completed dismantling two frames on the opposite side of the receiving track, proceed to cut up the two new frames.



Special rig used for dismantling car trucks

To reduce the underframe to melting steel of charging-box size, two or three cuts, depending upon the type of frame, are made to detach the bolster from the center sill. Two or three cuts are also made to detach the needle beams from the sill, and the end sills, if any, are cut in the middle. The center sill is then cut longitudinally, one cut sufficing for shallow sills, while two cuts are made on fish-belly sills to reduce the width of the scrap to 18 in. or less. Depending upon the length, from 7 to 9 cross cuts are made in the sill to reduce the metal to lengths of 5 ft. or less. As this cutting proceeds the hose and couplings are removed, air cylinders and reservoirs are separated from the sill, couplers and draft gears are separated and dismantled, and set aside or deposited in one or more of 28 trays placed along one side wall of the shop for materials to be used again or to be further inspected at Milwaukee before they are scrapped. The scrap iron on the floor is then gathered by laborers and hoisted into the nearest car by a crane truck. The floor is then made ready for two more underframes. The work of placing, cutting and disposing of the scrap and salvaged material for two underframes takes about two hours, or one hour per underframe, during which the cutters and laborers shift from the two underframes on one side of the receiving track to those on the other side, as their work progresses. Meanwhile, the trucks are undergoing dismantling in the South shop.

Counterbalance lead is melted out of scrapped driving-wheel centers and cast into pigs

Counting from one end of the truck-dismantling shop, which has ten tracks, the first track is used for empty cars required in either shop, the second is reserved for cars being loaded with mounted wheels in good condition, the third for storing mounted wheels preparatory to loading, the fourth is assigned to cars being loaded with scrap wheels, the fifth is used for dismantling trucks, the sixth for loading scrap, the seventh for dismantling trucks, the eighth for loading good bolster and spring planks, and the ninth and tenth for miscellaneous purposes.

Dismantling Car Trucks

When arch-bar trucks are received the two box bolts at each end are cut and the bottom tie bar is severed at each end. A lift truck then lifts the assembly free from the wheels and lays it to one side, where the springs, bolsters and spring planks are sorted out, the malleable iron detached and the rest of the metal reduced to melting steel. Meanwhile, the packing is removed from the journal boxes, the boxes removed from the axles, and the brasses and wedges separated. A similar procedure is followed with trucks equipped with T-section side frames, which are also scrapped, except that after the side frame is cut in dismantling, a special rigging mounted on casters and equipped with three chain blocks, suspended from a cross arm, is used to dismember the assembly. Trucks having U-section side frames with wheels in good condition are not dismantled but are moved by the transfer table from the underframe shop to an outside track where they are shipped for installation under serviceable cars undergoing repair at other points.

Mounted wheels in good condition are separated from scrap wheels. All wheels and axles are moved, two pairs at a time, by lift truck from the dismantling floor to the loading track and then are hoisted into cars by an electric crane truck for shipment to Milwaukee. This truck also loads all brake beams, usable bolsters and spring planks. With the aid of a magnet the same truck loads all melt-

Materials to be repaired or held for further inspection are deposited in bins along the shop wall

ing scrap into cars spotted on either side of each dismantling track. Journal boxes, brasses, wedges, coil springs, etc., are deposited in trays placed against one side of the shop for movement by lift truck to storage at Dubuque if the material is usable without further inspection; otherwise to an outside platform for shipment on trays to the Milwaukee stores.

This shop, like the underframe shop, is organized to dismantle and dispose of the material for the trucks of 32 cars per day, working two shifts, the present force including two cutters per shift, two bolster dismantling men, one man assigned to collect journal packing, and two men to handle journal boxes, brasses, etc., while a crane-truck operator and a floating laborer are employed to load all scrap and two other men are occupied in preparing empty cars for wheels and otherwise to assist in loading wheels. Any slack time is utilized by dismantling trucks from locomotive tenders.

A Locomotive Scrapped Each Day

Dismantling of locomotives and tenders is independent of the car work and is all performed outside. The locomotives are dismantled on one track, the cranes working on a parallel track and loading the scrap into cars on a third parallel track. Other tracks are used for storing locomotives awaiting dismantling and for handling tender work. Usually two locomotives undergo dismantling at the same time, during which they are moved progressively from one end of the track to the other. In the first position the piping and fittings and front end are removed and the cab is lifted and burned on adjacent property. The locomotive is then moved to the second position where the jacket and lagging are removed and laid to one side in containers. In the same location the barrel of the boiler is reduced to four pieces by making two cuts around the shell and cutting lengthwise just above the belly sheet. This metal is immediately loaded into a car, the flues into another car, and the back end is loaded uncut into another car. If the boiler is small, it is sold uncut.

The locomotive is then advanced to another position forward where the frame and running gear are reduced to scrap by oxy-acetylene cutters and loaded into cars. The cylinders are completely dismantled in this operation. The locomotive is then moved to the next position for dismantling the wheels. The driving boxes, if of steel, are removed and laid aside for shipment to Milwaukee, together with leaf springs and other articles subject to repair or further inspection. If the tires are worn out, they are cut free from the wheels, and the axles are then cut. Wheels with good tires are placed horizontally on a block and the tires removed with a heater ring and fuel oil; the wheel centers are next placed in an improvised forge and the lead in the counterbalances melted and collected into molds for reuse.

Meanwhile, on nearby tracks, tenders are cut loose from the underframes, dumped on the ground and cut into heavy melting steel, and the trucks moved by a lift truck into the shop for dismantling. Locomotives are being dismantled and the materials disposed of at the rate of seven or eight locomotives per week, using a force of nine cutters, eight laborers and two crane operators, working one shift.

Cost of Dismantling

Detailed costs of the Dubuque operation are prepared each month from daily reports of the equipment dismantled and from expense accounts for labor and material, and, by time studies. It is estimated on the basis of shipments made that 95 per cent of the locomotives are reduced to scrap and 60 per cent of the metal in cars. The remaining 40 per cent includes materials retained at Dubuque for further use, also mounted wheels, brake beams and other materials shipped to Milwaukee for repair or sale when inspected and separated.

The cost of the operation includes all charges for supervision, labor and material at Dubuque, and all switching charges and expenses for heat, light and power, but excludes taxes and other overhead on the property. The cost covers dismantling, preparation of scrap for sale and the handling of both scrap and serviceable material. The combined cost of dismantling and handling in June, 1935, when 9,027 tons of metal were handled, was $1.96 per ton. The figure includes 71 cents per ton for dismantling, 85 cents for cutting scrap, and 40 cents for loading and sorting this scrap. Of this the labor cost was $1.35 per ton. The cost in June of dismantling and handling material from 482 freight cars, containing 6,602 tons of metal, was $1.82 per ton, consisting of 47 cents for dismantling, 93 cents for cutting scrap, and 42 cents for loading and sorting scrap. Of this the labor cost was $1.31 per ton. The cost of dismantling and handling the material from 20 locomotives with 1,873 tons of metal in June was $2.28 per ton, consisting of $1.46 per ton for dismantling, 49 cents for cutting, and 33 cents for loading and sorting the scrap. Of this the labor cost was $1.34 per ton.

Old couplers are moved eight at a time

Non-articulated 4-14-4 Type Locomotive Built in Russia*

By D. Babenko

Heavy freight locomotive with unusual wheel arrangement and interesting features designed to meet unusual conditions

A STUDY to determine the heaviest type of freight locomotive that could be used on Russian railroads was initiated in 1930. The investigation was coupled with considerations involving the adoption of automatic couplers. Operating conditions imposed the following restrictions under which the design was to be worked out: (1) Locomotive must operate on existing light track where the rails weigh only 76 lb. per yard. To relay the track with rails weighing 100 lb. or more per yard and to replace the present light bridges was considered prohibitive. (2) Curves in main-line track of 525-ft. radius must be negotiated at full speed, and even sharper curves at reduced speeds. (3) Operating speeds up to 43.5 m. p. h. (4) Trains of 2,750 short tons to be run at a speed of 15 m. p. h. on specified heavy grades. (5) Wear of track on curves and side thrusts to be as low as possible. (6) Stresses on the track, due to dynamic augment at highest running speeds, not to be dangerous despite the light weight of the rails. (7) Fuel to be coal of available low grade and slow-burning quality. (8) Axle load limited to 20 metric tons, or 44,000 lb. (9) Tractive force at least 60,000 lb. at speed.

It will be readily seen that the above restrictions made the working out of the design a particularly difficult one and raised many problems which had to be solved before construction could be started. Calculations showed that a locomotive which would meet the requirements would have to weigh about 308,000 lb. on the drivers and have a rated starting tractive force of 88,000 lb. Furthermore, the adhesive weight would have to be distributed on seven axles.

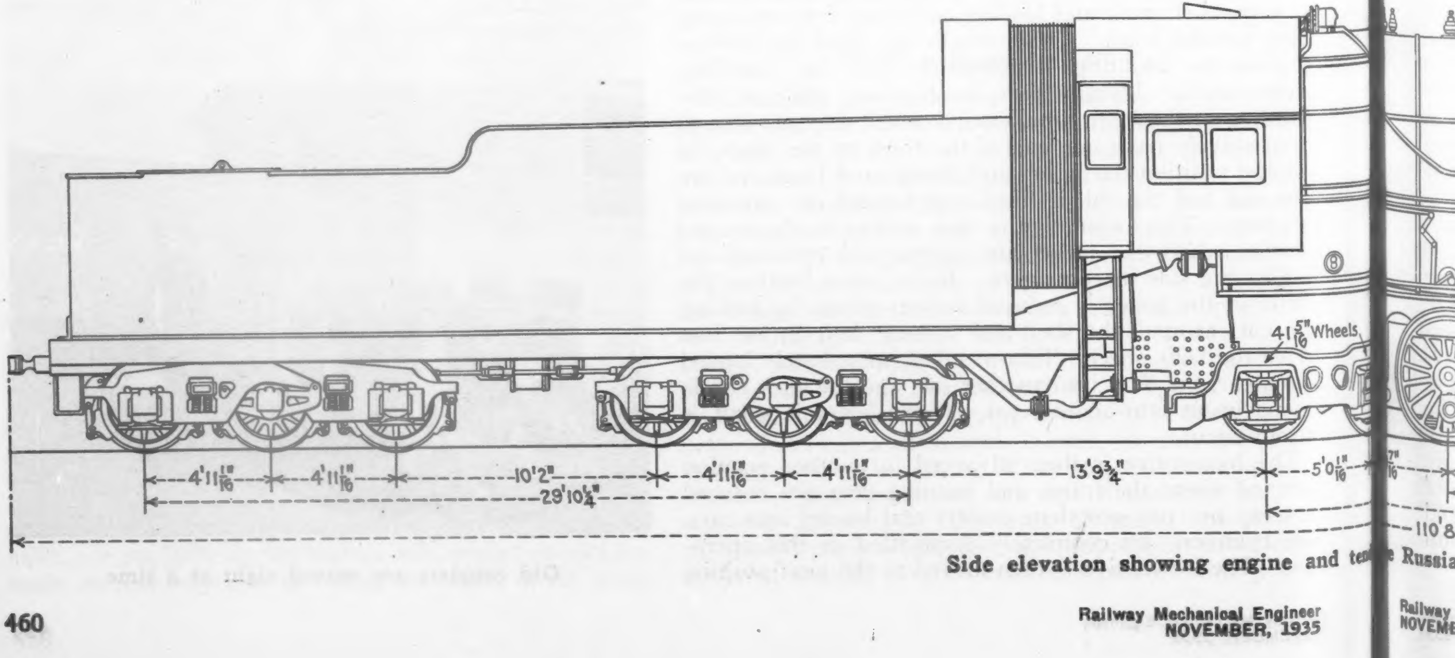
The use of articulated locomotives, such as the Mallet or the Garratt was naturally given consideration, but in view of their rather low efficiency and heavy maintenance costs, the adoption of an articulated design was not considered advisable.

The only alternative to an articulated design was the use of a larger number of coupled axles in a locomotive having a single frame—a greater number than on any locomotive then in operation in Russia. Continuing the investigation, which was started in the spring of 1930, it was found that non-articulated locomotives of the 2-10-0 type were being operated successfully in Germany, also locomotives of the 2-10-2, 2-10-4, 4-10-2 and 4-12-2 types in the United States. These locomotives were of the desired power, but in most cases they had an axle load in excess of 60,000 lb. Due to the greatly restricted axle loads—44,000 lb. per axle—necessary for operation on 76-lb. rails, a locomotive of the desired power would require the employment of seven coupled axles, or a locomotive of the 2-14-2 type. A preliminary design of a two-cylinder, 2-14-4 type locomotive was worked out in the early part of 1931, for which a four-wheel trailing truck was provided, due to the large firebox found necessary.

After the preliminary design had been gone over and had received tentative approval, it was decided that it would be advisable before starting construction to send representatives to other countries to investigate the results obtained from locomotives having five or six coupled axles. Accordingly, three engineers were sent to Germany and later to the United States, where they investigated manufacturing and maintenance facilities and inspected and rode on a number of heavy, non-articulated locomotives.

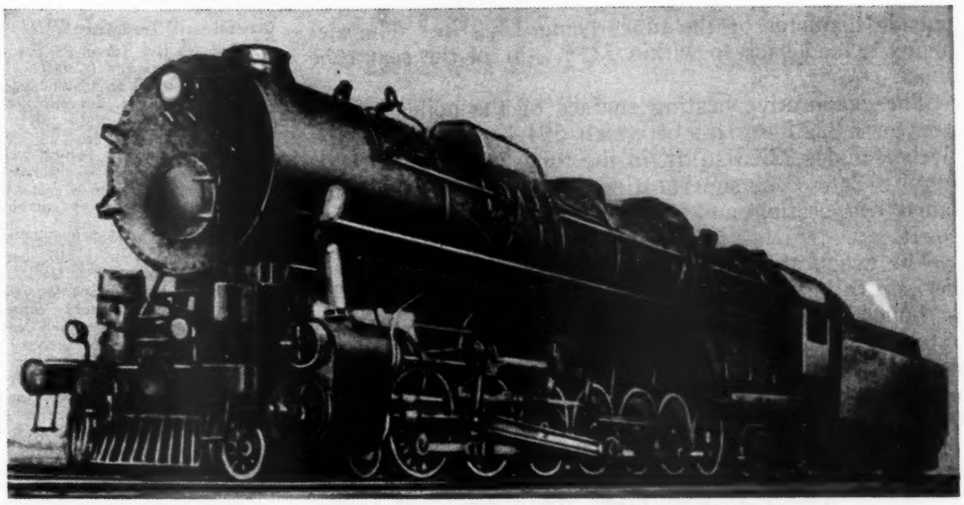
Upon their return the preliminary designs for a 2-14-4 type locomotive were again gone over in light of the

* From a translation of an article which appeared in "The Motive Power," published in Moscow, U.S.S.R.



Side elevation showing engine and te

Light track and heavy grades induced U.S.S.R. engineers to design and build a 4-14-4 type locomotive



information gathered and a modified design was worked out for a locomotive of the 4-14-4 type. After the design had been checked and approved an order for the construction of a sample locomotive was given to the Lugansk Locomotive Works.

The locomotive has now been completed and has made some trial runs before being placed in service. Handling a train of 1,400 short tons, a speed of 25 m. p. h. was obtained on a heavy grade, under which conditions the locomotive developed 3,000 hp. When cold the locomotive was pulled around a curve of 453-ft. radius; under steam it passed over a curve of 820-ft. radius at a speed of 28 m. p. h.

This locomotive weighs 458,435 lb. in working condition, of which 308,560 lb. is carried on the 14 driving wheels. The four-wheel engine truck carries a load of 68,325 lb. and the four-wheel trailing truck, 81,350 lb. The driving wheels are 63 in. in diameter, the two cylinders are 29⅛ in. in diameter, and have a stroke of 31⅞ in., while the boiler pressure carried is 242 lb. per sq. in. The rated tractive force on an 85-per cent basis is consequently 88,250 lb. The light weight of the locomotive is 399,600 lb.

The wheel base of the locomotive is 56 ft. 9⅞ in., and that of the locomotive and tender, 105 ft. 5⅞ in. The driving-wheel base is 32 ft. 11⅝ in. The length of the locomotive between coupler faces is 67 ft. 11⅝ in., and the combined length of the locomotive and tender is 110 ft. 8$^{3}/_{16}$ in.

The tender weighs 275,500 lb. in working order, or 130,040 lb. light, and is mounted on two six-wheel trucks of the Buckeye type, of 9 ft. 10⅛ in. wheelbase. It has a capacity for 11,620 U. S. gallons of water and 24.2 tons of coal. The length of the tender between coupler faces is 44 ft. 1¼ in. and the wheel base 31 ft. 6⅛ in.

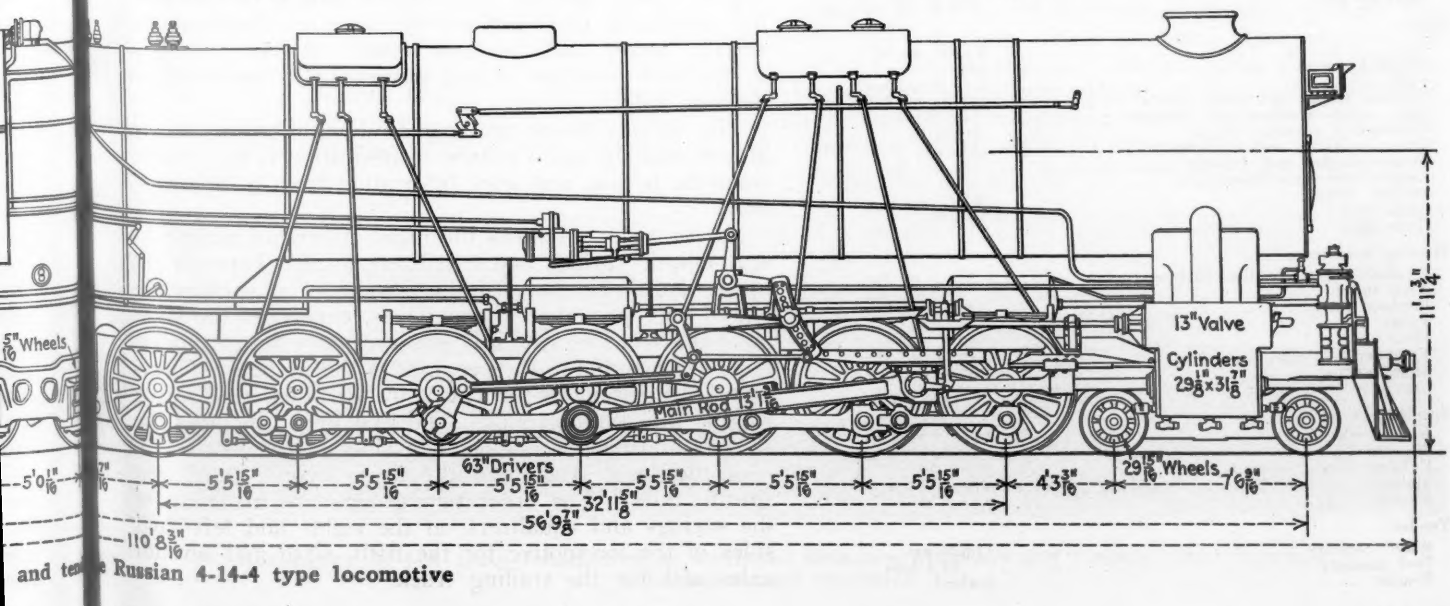
Many of the features of this unusual locomotive are particularly interesting.

Especially noticeable is the large size of the boiler and the firebox. The boiler is of the straight-top radial-stayed type, the center line being 11 ft. 11¾ in. above the top of the rail. The total length of the boiler is 58 ft. 7⅝ in. and its weight is approximately 132,000 lb. The firebox is 15 ft. 9 in. long and 8 ft. 2$^{7}/_{16}$ in. wide, which gives a grate area of 129.2 sq. ft. Such a large grate area would not be required were the coal not of such a low grade. The grates are of the shaking type and a grate shaker operated by either steam or compressed air is provided. The coal is fed by a mechanical stoker. The ash pan is of the hopper type.

A combustion chamber, 8 ft. 2$^{7}/_{16}$ in. long, is provided which increases the firebox volume to 865.2 cu. ft. A brick arch is applied, the arch being carried on four arch tubes of 3½ in. diameter.

There are 138 fire tubes, 2¾ in. outside diameter, and 48 flues, 6¾ in. in diameter. Tubes and flues are 22 ft. 11$^{9}/_{16}$ in. long. This great length accounts for the use of tubes and flues of such large diameter.

The Chussov superheater is of the six-tube type, the



Russian 4-14-4 type locomotive

outside diameter of the tubes being $1\frac{3}{16}$ in. The elements extend back to within $22\frac{13}{16}$ in. of the rear tube sheet.

The evaporative heating surface of the boiler has an area of 4,822.7 sq. ft., of which 594.4 sq. ft. is in the firebox and 4,227.3 sq. ft. in the tubes and flues. Adding 1,872.9 sq. ft. superheating surface brings the combined evaporating and superheating surface to 6,695.6 sq. ft.

The evaporative capacity of the boiler is estimated to be 73,716 lb. per hour, which corresponds to a potential or boiler horsepower of 3,880. Assuming a combustion rate of 82 lb. per sq. ft. of grate per hour, the total amount of coal burned would be 10,594 lb. per hour. If cne horsepower could be developed for each 2.65 lb. of coal, the total horsepower would be 4,000.

A particularly interesting feature of the boiler construction is the extensive manner in which welding was employed, mainly to keep down the weight, but partly to permit of the use of sheets of readily available sizes. All welded seams are of V shape and are located between lines of staybolts. The firebox sheets, both inside and outside, are welded, being formed of several sheets joined together by welding. The crown sheet and back boiler head are also made of two or more sheets with welded joints.

Table of Dimensions, Weights and Proportions of the Russian 4-14-4 Type Locomotive

Railroad	U. S. S. R. (Russian)
Date built	1934
Builder	Lugansk Loco. Works
Type of locomotive	4-14-4
Service	Freight
Track gage	5 ft.
Cylinders, diameter and stroke (2)	$29\frac{1}{8}$ in. by $31\frac{7}{8}$ in.
Valve gear, type	Walschaert
Valves (piston type):	
Size	13 in.
Maximum travel	$7\frac{13}{16}$ in.
Steam lap	2 in.
Exhaust clearance	0 in.
Lead in full gear	$\frac{5}{16}$ in.
Weights in working order:	
On drivers	308,560 lb.
On front truck	68,325 lb.
On trailing truck	81,550 lb.
Total engine	458,435 lb.
Tender	275,500 lb.
Wheel bases:	
Driving	32 ft. $11\frac{5}{8}$ in.
Total engine	56 ft. $9\frac{7}{8}$ in.
Total engine and tender	100 ft. $5\frac{7}{8}$ in.
Wheels, diameter outside tires:	
Driving	63 in.
Front truck	$29\frac{15}{16}$ in.
Trailing truck	$41\frac{5}{16}$ in.
Journals, diameter and length:	
Driving, main (No. 4)	$12\frac{5}{8}$ in. by $14\frac{15}{16}$ in.
Driving, tandem (No. 5)	11 in. by $14\frac{15}{16}$ in.
Driving, others	$9\frac{7}{16}$ in. by $14\frac{15}{16}$ in.
Front truck	$7\frac{1}{2}$ in. by $13\frac{3}{4}$ in.
Trailing truck	$7\frac{7}{8}$ in. by $13\frac{1}{4}$ in.
Boiler:	
Type	Radial stayed
Steam pressure	242 lb.
Fuel	Low grade coal
Firebox, length and width (grate)	189 in. by $98\frac{7}{16}$ in.
Arch tubes—number and diameter	4—$3\frac{1}{2}$ in.
Combustion chamber length	$98\frac{7}{16}$ in.
Tubes—number and diameter	138—$2\frac{1}{4}$ in.
Flues—number and diameter	48—$6\frac{3}{4}$ in.
Length over tube sheets	22 ft. $11\frac{9}{16}$ in.
Firebox volume	865.2 cu. ft.
Grate type	Shaking
Grate area	129.2 sq. ft.
Heating surfaces:	
Firebox and combustion chamber	543.2 sq. ft.
Arch tubes	52.2 sq. ft.
Firebox, total	595.4 sq. ft.
Tubes	1,942.1 sq. ft.
Flues	2,285.2 sq. ft.
Total evaporative	4,822.7 sq. ft.
Superheating	1,872.9 sq. ft.
Combined evaporative and superheating	6,695.6 sq. ft.
Special equipment:	
Brick arch	Yes
Superheater	Chussov
Exhaust steam injectors	2
Stoker	Yes
Booster	No
Tender:	
Water capacity	11,620 gal.
Fuel capacity	24.2 tons
Trucks	6-wheel
General data (estimated):	
Rated tractive force, 85 per cent	88,250 lb.
Boiler horsepower (Cook)	3,880 hp.
Speed at 1,000 ft. piston speed	35.3 m.p.h.
Piston speed (ft. per min.) at 10 m.p.h.	283.5
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	67.4
Weight on drivers ÷ tractive force	3.5
Total weight engine ÷ potential horsepower	118.2
Total weight engine ÷ combined heating surface	68.5
Boiler capacity and proportions:	
Evaporative capacity, lb. per hr. (with heater), estimated	73,716
Equivalent evaporative (sq. ft. heating surface per hr.) (with heater), estimated	15.3
Firebox heat. surface, per cent com. heat. surface	8.9
Tube-flue heating surface, per cent combined heating surface	63.1
Superheating surface, per cent comb. heat. surface	28.0
Firebox heating surface ÷ grate area	4.6
Tube-flue heating surface ÷ grate area	32.7
Superheating surface ÷ grate area	14.5
Combined heating surface ÷ grate area	51.8
Potential horsepower ÷ grate area	30.0
Combined heating surface ÷ potential horsepower	1,725
Tractive force ÷ combined heating surface	12.28
Tractive force × diameter drivers ÷ combined heating surface	774

The boiler is fed by two exhaust-steam injectors having a capacity of 95 to 100 U. S. gallons per minute. Two Friedman live-steam injectors, having a capacity of 45 to 48 U. S. gallons per minute are also provided. Two blow-off cocks are applied on each side of the firebox.

The frames are cast steel, being the first ones made at the Lugansk Locomotive Works. The thickness or width of the frames is $5\frac{1}{2}$ in.

One of the most difficult of the problems which the design of this locomotive presented was the provision for safely passing around sharp curves at considerable speed and the avoidance of heavy side thrusts and side wear of the rails due to the long wheel base. As will be noted from the illustration of the locomotive, the cylinders are coupled to the fourth pair of drivers.

The third, fourth and fifth pairs of drivers have bald tires $6\frac{7}{8}$ in. wide. The first and second pairs of drivers are arranged to have a lateral motion of $1\frac{1}{16}$ in. each side of the center. No lateral motion is provided for on the sixth pair of drivers, but the seventh pair has provision for $1\frac{3}{8}$ in. lateral motion each side of the center. The first truck is designed for $5\frac{11}{16}$ in. lateral motion to the right and left and the trailing truck with $1\frac{3}{8}$ in. lateral motion. The lateral motion of the driving wheels is provided for by clearance between the driving boxes and the hub liners. A lateral-motion device with equalizer spring suspension is provided on the rear axle.

The driving boxes are cast steel with bronze crown brasses and the usual cellars. Lubrication is by packing from the bottom and wick lubrication from a top reservoir.

Spring rigging follows the usual American practice—semi-elliptic springs and equalizers located between the upper and lower bars of the frame. The springs are placed on top of the driving boxes, except on the sixth and seventh axles where it was necessary to use underhung springs due to the presence of the firebox. Three-point suspension is provided by dividing the spring rigging into three groups. The first group includes the springs and equalizers—on both sides of the locomotive—of the front truck and the first, second, third and fourth axles. The other two groups are made up of the springs and equalizers on the right- and left-hand sides of the locomotive for the fifth, sixth and seventh axles and for the trailing truck.

Unusual Main and Side Rods

The design of the rods and motion work presented another interesting problem. As previously stated, the main rods are connected to the crank pins on the fourth pair of drivers. The main rods are 13 ft. $1\frac{9}{16}$ in. long. Despite their great length the distance between the center of the cylinders and the fourth axle is so great that the piston rods are 13 ft. $1\frac{9}{16}$ in. long. To keep down the reciprocating weights and to make unnecessary the employment of piston rods of abnormal diameter, resort was had to a secondary supporting crosshead located midway between the cylinder and the main crosshead. The main cross head is of the multiple ledge type developed on the Pennsylvania railroad.

A tandem main rod serves to connect the fourth to the fifth pair of drivers. The eccentric crank for the Walschaert valve motion is placed on the fifth crank pin. The distance from the eccentric crank to the reverse link was so great that the eccentric rod was divided and an intermediate supporting rocker arm was introduced. Extension rods are used to support the main cylinder pistons and also the piston valves.

In the side rods connecting the first and second pairs of wheels and also the sixth and seventh pairs universal joints with vertical and horizontal pins are provided to permit the allowed lateral motion. The side-rod crankpin bearings on the first, second, sixth and seventh pairs of wheels are of the ball type. All rods are fitted with floating bushings and are arranged for grease lubrication. Axles and crank pins are hollow bored.

Other Details Are Interesting

Piston valves are 13 in. in diameter and have a maximum travel of $7\frac{13}{16}$ in. A power reverse gear is fitted.

There are two large sand boxes with 14 pneumatic sanders for supplying sand to the front side of all driving wheels.

A multiple throttle valve with six valves and one pilot valve is installed. There is a stop valve in the dome.

Air brakes are provided, air being supplied by two cross-compound air compressors located on the front deck ahead of the cylinders. Drive brakes are of the Kasantzeff design with brake shoes on the front side of all driving wheels, except those on the front and rear axles where brake shoes are omitted on account of the great amount of lateral motion. Clasp brakes are used on the six wheel tender.

Notwithstanding the heavy weight of the moving parts (main rod 1,610 lb.; piston, piston rod and crosshead 2,485 lb.) and the high running speed of 43.5 m.p.h. anticipated for the locomotive, it was possible to counterbalance all the rotating masses and the necessary part of the reciprocating parts.

The weights and leading dimensions are given in an accompanying table.

Burlington Applies Timken Driving Boxes

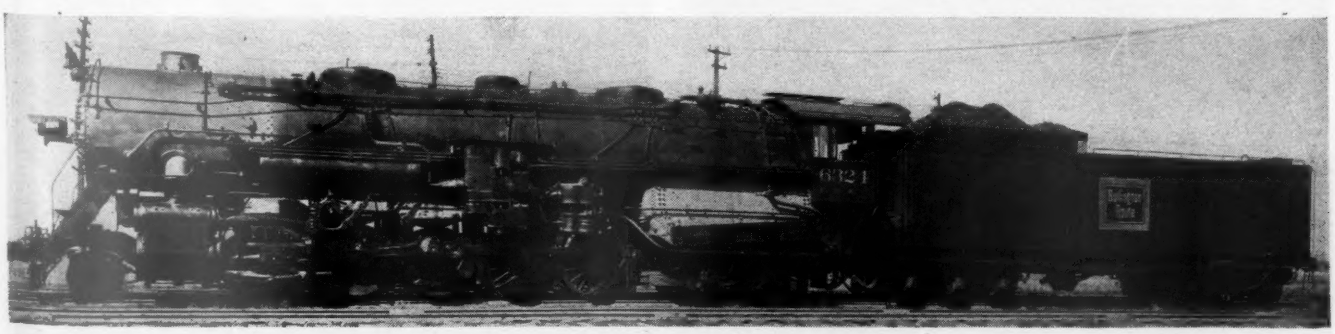
THE Chicago, Burlington & Quincy has nearly completed a locomotive-reconditioning program at its main shops at West Burlington, Iowa, whereby six 2-10-4 type locomotives are being equipped with smaller cylinders and Timken roller bearings on all engine-truck, driver and tender wheels. Lighter rods are being applied and necessary revisions in valve motion made to adapt these locomotives for relatively higher speeds than those contemplated in the original design. As a matter of fact, these locomotives, Baldwin-built about eight years ago and now known as the Burlington M-4-A class, are being transferred from heavy coal service on the Beardstown (Ill.) division to lines West where they will replace 4-8-4 type locomotives now being used for fast freight service on lines East.

The Burlington M-4 class locomotive, before conversion, had 31-in. by 32-in. cylinders, 64-in. driving wheels, tandem main rods, carried 250 lb. steam pressure and weighed 512,110 lb. total engine weight. The 15-in. valves were set for $\frac{1}{4}$-in. lead and $2\frac{1}{2}$-in. lap, having

One of the reused wheel centers with bore built up by welding to accommodate a $\frac{1}{2}$-in. reduction in axle size

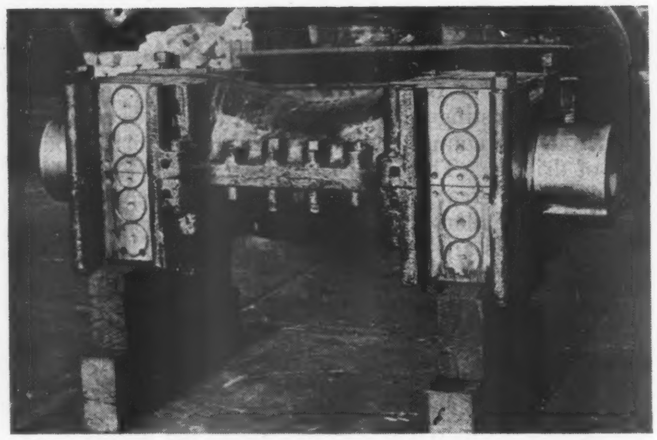
a valve travel of $8\frac{1}{2}$ in. and a maximum cutoff of 61.4 per cent. The locomotive was designed for a maximum speed of 35 m.p.h. and developed a tractive force of 90,000 lb.

In the converted M-4-A class locomotive, Commonwealth one-piece cast-steel cylinders are applied, having the cylinder size reduced to 28 in. by 32 in. and the valve diameter to 14 in. Boiler dimensions and pressures are unchanged; also the wheel diameter. This reduction in cylinder size reduced the tractive force to 83,500 lb., but permitted a weight reduction which, in conjunction with the reduced weight of the solid back-end main rods, effected a weight saving of approximately 17,000 lb. per locomotive. With lighter reciprocating parts and



Burlington M-4-A class locomotive as equipped with new cylinders and Timken roller bearings for high-speed operation

Application of permanent steel wedge *A* by welding to give a straight pedestal jaw—The method of holding bronze wear plates *B* in place and of applying steel lateral thrust plate *C*



Main axle and Timken roller-bearing box assembly ready for application of the driving wheels

Scullin cross-counterbalanced double-disc main wheels, the speed of the locomotive has been stepped up to 55 m.p.h., with certain modifications in valve setting to accommodate the higher speed.

The revised valve motion is set to provide ¼ in. lead, 1⅜ in. lap and ⅛ in. exhaust clearance. The total valve travel is 8⅞ in. and the cutoff not limited. Locomotive 6327, the first of the M-4-A type, was turned out of the shop in November, 1934, and has given a very good account of itself in service on lines West since that time. An important factor in this successful high-speed operation is the Timken roller bearings which were applied to all engine-truck and driver wheels. The tenders are also being equipped with American Steel Foundries roller-bearing wheel units and Timken bearings.

General Method of Procedure

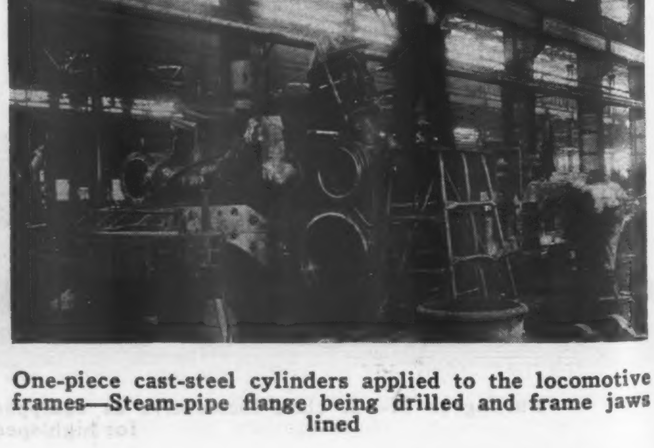
New Commonwealth one-piece cast-steel cylinders, applied to the M-4 locomotives, were furnished by the General Steel Castings Corporation, machined at the Baldwin Locomotive Works, Philadelphia, Pa., and received at West Burlington shops ready for application. Back cylinder heads also were cast integral and designed for use in conjunction with Anderson integral-type crossheads and piston rods.

In converting one of the M-4 locomotives, the frames are removed, sandblasted and steel wedges applied by intermittent electric welding, as shown at *A* in one of the illustrations, to make the wedge sides of the pedestal jaws parallel, as required for the roller-bearing boxes. The locomotive frames are milled in pairs on a Lucas boring mill, as described in an article on page 404 of the September *Railway Mechanical Engineer*. The straight pedestal jaws are milled to provide the necessary width and larger fillets cut. One-half inch of metal is removed from the shoe side of the main jaws and ¼ in. from the shoe side of all other jaws. The wedge sides are simply cleaned up. A fly tool is used for enlarging the corner fillets and ½ in. is milled from the upper surfaces of the pedestal binders to accommodate the larger boxes. An accuracy of not less than .015 in. is required in these various machining operations.

The frames are lined up in the erecting shop and the one-piece cast-steel cylinders are bolted in place, as shown in one of the illustrations. In lining the frames, fine lining strings are extended back from the cylinder centers and the main frame jaws squared with these lines and properly located in accordance with the customary practice. Trams are then used to check the location of front and back frame jaw centers.

Special bronze liners *B* are applied, using nine steel staybolt bushings 1⅜ in. in outside diameter and ¼ in. thick, with a ⅞-in. hole in the center, this center hole being used for welding the bushings to the frame jaws. Only a single bead of welding rod is required in applying the bushings. The bronze liners, with suitable holes to accommodate these bushings, are thus held securely in place without tack welding which has been found unsatisfactory for this application. The bronze plates are then dressed with a file to give a .010-in. minimum clearance over the Timken boxes. Referring again to the frame jaw illustration, the method of applying hard-

One of the new Scullin double-disc main wheel centers ready for pouring lead into the counterbalance



One-piece cast-steel cylinders applied to the locomotive frames—Steam-pipe flange being drilled and frame jaws lined

The running gear, including Scullin double-disc main wheels, on a revised Burlington M-4-A locomotive

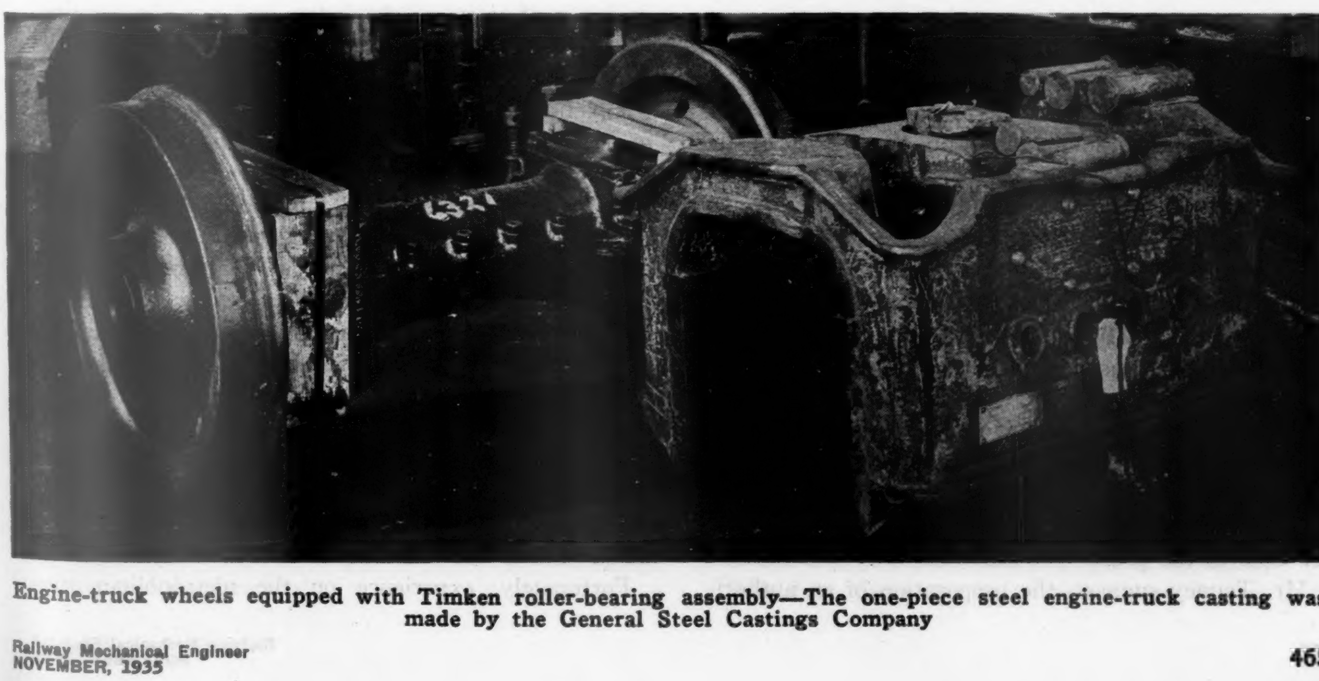
ened steel wear plates which take the side thrust of the driving boxes, is shown at *C*. Intermittent electric welding is used to hold each wear plate firmly in place against the frame jaw.

The main driving wheels were renewed with the Scullin double-disc type, cross-counterbalanced. No hub plate is required, as the lateral play is taken care of between the pedestal ways and the frame jaws. Other than main wheels were not renewed, but it was necessary to reduce the axle fit size to accommodate a ½-in. reduction in axle size. The wheel center is built up in the wheel fit by electric welding, as shown in one of the illustrations. In this operation, a ½-in. mild-steel ring is spotwelded in place at the center of the wheel fit to serve as a welding guide. One-half of the wheel fit is then built up by electric welding, using coated wire, and the wheel turned over and the other side completed. A welded steel liner is also applied to fill the hub-plate cavity. During this operation, the outer rim of the wheel center is heated by means of a charquet fire to provide for expansion. After welding, the wheel centers are normalized.

The axles are ground and the wheel centers bored to fit. Keyways are laid out and cut, the wheels being mounted (pressed not quite home) on the axle and the keys fitted before quartering. For the latter operation the top of the roller-bearing usually has to be removed, the bottom half being clamped to the axle. The crank-pin holes are bored to the correct size and accurately quartered, the crank-pins then being pressed in and riveted. The top of the roller-bearing housing is then replaced and the wheels pressed completely on. The wheel-center bore is machined .002 in. to .003 in. smaller than usual in order to get proper mounting tonnage. This is necessary because the wheel fit has been built-up by welding.

The engine-truck, roller-bearing wheel assembly and casting used are shown in another of the illustrations. The engine-truck radius bar is shortened to suit the new truck frame and a new front equalizer provided. Center holes in the back equalizers and the fulcrum positions are changed to make a necessary redistribution in weight. Driving box saddles at the main wheels are reduced in height ½ in. to accommodate the Timken roller-bearing housing. Driver-brake cylinders over the front driving axle are removed and relocated 4½ in. higher to clear the top of the Timken roller-bearing housing. Driver-brake bell-crank levers are reshaped to clear the underside of the housing and new driver-brake cylinder push rods were required on account of these changes.

Alemite fittings are applied to the rods, crank pins, knuckle pins, wrist pins and valve motion. A Centrifix steam conditioner is applied in the steam dome. Four Prime steam-operated, automatic, cylinder-relief valves are applied in place of the cylinder cocks formerly used. For the exhaust channel drains, two Watertown automatic cylinder cocks, piped independently of the cylinder-relief valves, are reapplied. Additional splash-plates are applied in the tender tank to prevent surging of the water in this large tank under increased operating speeds.



Engine-truck wheels equipped with Timken roller-bearing assembly—The one-piece steel engine-truck casting was made by the General Steel Castings Company

EDITORIALS

Fruit Of Communism

Those who read the description of the 4-14-4 type Russian locomotive, taken from a translation of an article which appeared in a Russian technical periodical and printed elsewhere in this issue, will no doubt observe the numerous respects in which the design follows American practice, even to the inclusion of copies of specific devices, such as the Buckeye type tender trucks, the Tandem main rods, the Pennsylvania multi-ledge type of guides, the power reverse gear, and others.

They will, then, find the author's concluding paragraphs (not included in our article) of at least passing interest. We quote: "From this short description we see that Stalin's command 'to catch and get ahead of the most progressive, technically and economically, capitalistic country' in regard to locomotive construction is fulfilled. We have the right to be proud that the only powerful locomotive with seven driving axles under one frame, from top to bottom, is ours—designed by our young specialists and built at our plant by our workers and engineers out of our materials.

"This becomes possible due to the socialistic reconstruction of the country which reached such a tremendous stage under the wise guidance of Lenin's party and her genial leader, Comrade Stalin."

Non-Train Accidents

J. R. Tenney, superintendent of safety of the Western Maryland, in commenting on the report of the Committee on Non-Train Accidents at the recent meeting of the Safety Section of the Association of American Railroads, said that, "where better tools and equipment are involved, as in the prevention of accidents due to the collapse and fall of objects, the trend has been downward faster than the non-train accidents as a whole, whereas in accidents due to causes under the control of the workman, that is, falls of persons, the downward trend has lagged behind the downward rate of all non-train accidents. Experienced safety men have pointed out that the education and training of both the supervision and the men is more than 90 per cent of the job."

Mr. Tenney suggests the preparation of an authoritative, comprehensive text book on this subject. This is excellent, but with it must go a very intelligent, positive and aggressive attitude on the part of the management that accidents must be stopped. It is hard to lay down exact rules for safety procedures. One executive will get splendid results from one course of action, while another will get equally good results with an entirely different approach. Education must be coupled with effective discipline and constant vigilance on the part of the executives and supervisors.

Some railroads have far exceeded others in safety performances. If a few roads can continually and consistently excel all others in this respect, it surely reflects in no uncertain manner on the administration and practices of those roads with the poorer records. Life and limb are too precious to be carelessly wasted and thrown away. Enough is now known about the best techniques and approaches in safety first efforts so that there can be no excuse for the laggards.

Safety and High Speed

The higher the speed at which a body is traveling the greater the difficulties and hazards in bringing it to a stop. The energy stored in a moving body is proportional to the square of the speed at which it is traveling. Hence, at 90 m.p.h. the energy stored in each ton of train weight is two and one-quarter times as much as at 60 m.p.h. If this energy is to be dissipated at the same rate in each case, the time for completing the stop from 90 m.p.h. will be two and one-quarter times as long as from 60 m.p.h. and the train will have moved more than three times as far. If the stop from the higher speed is to be made in the same time as the stop from the lower speed, the energy will have to be dissipated two and one-quarter times as fast and the train still will move about 50 per cent farther. If the stop is to be made in the same distance in each case, it must be completed in about one-third less time at the higher speed and the stored energy will have to be dissipated probably more than three times as fast. One of the fundamental problems in introducing higher train speeds, therefore, is that of providing means for controlling speed and stopping the trains quickly and easily.

Fortunately, experience on the metropolitan sub-

ways, where trains must be operated at close intervals with frequent stops, demonstrated the practicability of braking at high deceleration rates, although these trains are lighter than standard railway passenger equipment and do not operate at extremely high speeds.

Much as the public desires high-speed transportation, it will not use such carriers freely if the riding is so uncomfortable as to suggest hazards. Excessive noise and vibration, if not an indication of physical stress and possible accident, at least suggest that idea to the traveler.

Fortunately the American railroads for a number of years have been making unusual efforts to improve the comfort of travel and to insure still greater safety to passengers. This is indicated by easier riding cars, locomotives so designed as to pull the train with ease, and smoother riding roadbed and track. While improvements in these respects have been going on for many years, generally speaking, little advantage has been taken until recently in speeding up the trains.

The increasing use of the airplane for passenger transport and the generous reception by the public of the high-speed streamline trains, has awakened many of the railroads to the necessity of operating passenger trains at higher speeds.

Just what does this mean to the railroad organization? We have ample evidence of what has been done by the several roads which have taken the leadership in introducing high-speed trains. There is, of course, a tendency toward lighter weight equipment, made possible by taking advantage of new materials, improved methods of fabrication and better design. Easier riding trucks and improved and better spring suspension have been introduced. Specially designed motive power of light weight operates at high speeds and with less damage to track and roadbed. Thus far the higher speed trains have been introduced on the heavier traffic division, where more or less critical attention has already been given to roadbed and track. It is a relatively simple task, therefore, to carry this work a step further and iron out roughnesses and irregularities, and make other improvements to insure easy and smooth riding at high speeds.

Certain changes have been made in the signaling system, depending on the type of equipment which is being used on the high-speed trains and the facility with which it can be stopped. Operating department officers and employees have naturally been keyed up to a higher tempo. The equipment is inspected more critically en route and is given almost microscopic attention at terminals. Additional grade crossings have been protected and the roadbed is policed much more carefully than under former conditions.

It is only fair to say that the shortening of the schedules is not a fair indication of the increase in top speeds. Much time has been saved by doing less work at the stations and making fewer stops. Time is also saved by means which are provided for quicker acceleration and deceleration.

The safety-first movement has been making steady progress in recent years. The introduction of the high-speed trains, however, promises greatly to stimulate this activity. American railroads have made splendid records in the safe carrying of passengers. While records have also been greatly improved in casualties to employees, there is still much to be desired in this direction. Quite probably the introduction of the high-speed trains will stimulate interest in safety first to such an extent that greater efforts will be made throughout the entire railroad organization to improve safety conditions and that this will have a beneficial effect in reducing employee casualties, even in departments which are not actively engaged in getting the trains over the road.

Arch-Bar Trucks Continue To Fail

A limited number of railways have eliminated arch-bar trucks from their freight equipment, but most roads, as well as private car companies, can do little more than report progress in reducing the number of arch-bar trucks now in service. In fact, even this reduction has been accomplished more by the retirement of obsolete and worn-out cars than by the installation of new equipment with modern cast-steel side frames. The desirability of more general and rapid replacement of arch-bar trucks can hardly be questioned. The reason for the delay and the extension of the date when this type of truck will be prohibited in interchange, to January 1, 1938, is largely the difficulty in financing.

The point which should be borne in mind is that arch-bar trucks, continued in service, are a great source of expense to railroads since they constitute a frequent cause of train accidents and delays with attendant damage claims, wrecks to be cleared up, and track and equipment to be repaired, to say nothing of excessive maintenance costs for the arch-bar trucks themselves. There can be little doubt that, in some cases, railroads could spend substantially more money on arch-bar truck replacements than they do and yet save more than they spend.

According to a recent report of the Bureau of Safety, a study of 14 accidents which occurred during the past five years, involving arch-bar trucks, showed resultant death to 23 persons, injury to 24 persons and cost of damage to track and equipment and clearing the wreckage amounting to approximately $275,000. Of these accidents, seven occurred during the year ended June 30, 1935, and the expense reported represents only a small percentage of the cost to the railroads as the result of using arch-bar trucks. On one road, for example, the cost of repairs and the cost of accidents involving arch-bar trucks amounted to $183,817 in a single year, this amount being divided about equally between cost of repairs and expense of accidents.

The best thing to do with arch-bar trucks is to

eliminate them just as fast as practicable. A few railroads and private car companies are aggressively working toward this objective, and it may not be amiss to mention one of the latter. The Shell Eastern Petroleum Products, Inc., for example, is reported to have already equipped 135 cars with cast-steel side-frame trucks, specified the application of this type of truck to 70 new cars, and plans to install the trucks on 165 cars a year so that all cars belonging to this company will be equipped by January 1, 1938. This is a commendable example although admittedly one which may be hard to follow by railroads and private car companies owning large fleets of cars now fitted with arch-bar trucks.

We Need New Tools, But —

Numerous comments have been heard from railroad men who visited the recent Machine Tool Show at Cleveland and, without an exception, these comments have indicated that those who attended the show were more than repaid for the time they spent. It is also of incidental interest to add that several mechanical men who did not attend the show have expressed regrets that they did not go to Cleveland after having heard the opinions of others about the show. Most of the expressions of opinion from railroad men have had one thing in common and that is that, after having seen what the machine-tool industry has to offer in the way of modern cost-saving equipment for the shop, there is no question in their minds that the railroads could profitably replace a large part of the obsolete shop equipment which is now in service. Many of these men have summed up their comments with remarks to the effect that "We need new tools in the worst way and we could save money by buying them, but ——; we can't get the money to buy them."

Why can't the railroads get money to buy machine tools if they need them? We find this question very difficult to answer in the face of the knowledge that other progressive industries have recently gone into the market in a large way for new shop equipment. They have gone into the market for new shop equipment because they know that the only way in which they can reduce the cost of their product is to take advantage of the most modern equipment that will save them money in production. Do other industries need to save money any more than the railroads do?

In order to secure funds for capital expenditures railroad managements must have facts that will enable them to determine whether or not they are justified in making expenditures. Why should any railroad mechanical department officer or supervisor assume that his management is not willing to spend money for improvements when those improvements will pay for themselves in a short period of time? It is not the job of railroad executive officers who authorize expenditures to initiate investigations into the possibilities in individual departments of installing equipment that will reduce operating costs. As far as the mechanical department is concerned the responsibility for initiating such investigations rests with the chief mechanical officer. If we are to take seriously some of the comments we have heard from shop people, we might assume that mechanical officers do not welcome suggestions as to how they might save money in their departments. Our contacts with mechanical officers do not bear out any such assumption, and the question is naturally raised in our minds as to whether those who are responsible for shop operations are going as far as they should in apprising their superior officers of the opportunities for installing equipment that will save their company money.

Sometimes it requires a rather homely example to drive home just such a fact as this, and such an example is presented in a story which appears on page 477 of this issue of the *Railway Mechanical Engineer* under the title "No More Engine Failures." Here is a case which is probably typical of many such cases on railroads all over this country where the men down in the ranks have permitted conditions to exist which make it extremely difficult to do a good job. It is a case where an enginehouse foreman and a master mechanic have worried along month after month with inadequate machine-tool facilities which, because of their inadequacy, have resulted in serious and expensive failures on the road. One cannot read this narrative without wondering why it was that the enginehouse foreman did not tell the master mechanic and he in turn tell his superintendent of motive power how badly they needed some new machine tools before they were faced with an epidemic of engine failures.

There never was a time in the history of the railroads when they needed to save money as badly as they need to save it now. As far as the facilities are concerned with which the railroads maintain equipment, there is no question but that modern equipment is available that will enable them to reduce the cost of maintenance. In order to reduce these costs the management which authorizes expenditures must be informed as to how these savings can be made. It is the function of those down in the ranks in the mechanical department who are concerned with the operation of shops and enginehouses to inform management of the possibilities for reducing expenses and, when some railroad man makes the comment that "we need new machine tools in the worst way, but we cannot get the money," the question which we should like to ask is "Have you made an intelligent effort to collect the facts necessary to justify the management in appropriating the money?" We believe that railroad managements are sufficiently alive to the necessity for reducing expenses to give every consideration to proposals on the part of their departmental officers and supervisors for the installation of cost-saving equipment if these departmental men will take it upon themselves to present the story properly to the management.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

College Graduates

Many railway executives think that college men are out for high salaried white-collar jobs. This is not true. The large majority of us will accept any job, any hours and any wage to start. All we ask is a chance to prove ourselves.

Accidents to Employees

The railroads have made excellent progress in reducing the number of accidents to employees on duty, and yet the toll of life and limb is still entirely too large. In the I.C.C. summary of accidents to employees on duty for the year 1934, it is shown that 526 were killed and 16,990 injured. Most of these accidents were caused by carelessness and thoughtlessness on the part of employees. Some roads have made unusual and consistent records in reducing such casualties. Why not all of them? Apparently it is a matter of education and discipline—and grim determination on the part of those in charge to see that the workers protect themselves.

Training School for Young Engineers

Establish a training school for young railway mechanical engineers under the jurisdiction of the Mechanical or Research Divisions of the Association of American Railroads, the men to be taken in rotation from the various roads wishing to participate, for a few months each year of their apprenticeship. During this training a minimum wage would be paid and the cost shared by the railroads involved and the A.A.R. In this way the research work could be done more economically, the railroads would have better trained men, and the men would have a better and broader experience than they could obtain at ordinary apprentice work.

Locomotive Smoke Prevention

Attention was directed, at the September meeting of the Railroad Smoke Association of Hudson County, N. J., to the fact that most of the complaints during the summer months were about smoke made during the late afternoon and evening—that is, from 6.00 to 9.00 p. m. Apparently the men operating the engines know that the smoke inspectors have gone home and are not as careful as they are during the day. This is unfortunate. After all, it is the public that has set up the smoke abatement department and that pays the inspectors for checking up on the smoke and devising ways and means of minimizing air pollution. Is not this carelessness, when the inspectors are not on the job, an insult to the public intelligence?

Don't Waste Fuel

Fuel saving, good firing practice and improved methods of engine handling around terminals is a subject that should be kept before the rank-and-file by reviving the practice of posting educational posters and circulars about the shops and enginehouses. The few posters remaining about these parts have been hanging for a long time. A great many of us are like the willing but inexperienced fireman who started shoveling coal as fast as possible immediately upon leaving the terminal and stalled on the first hill. He looked into the blackened firebox and solemnly stated that he could not account for the lack of steam pressure on the gage, as there was an abundance of fuel in the firebox. Moral, he lacked technique—ours needs improving along the lines of fuel saving.

The Problem of Man-Power

If the railroads are to maintain or better their condition, they must compete with other industries for the best men for each type of work and train and use them in the most efficient manner.

May I make the following suggestion with respect to apprentices and special apprentices?

(1) That the American Association of Railroads or the *Railway Mechanical Engineer* sponsor a nation-wide contest annually for the best thesis on a mechanical railway subject, written by undergraduates working for a mechanical degree in their last year at college.

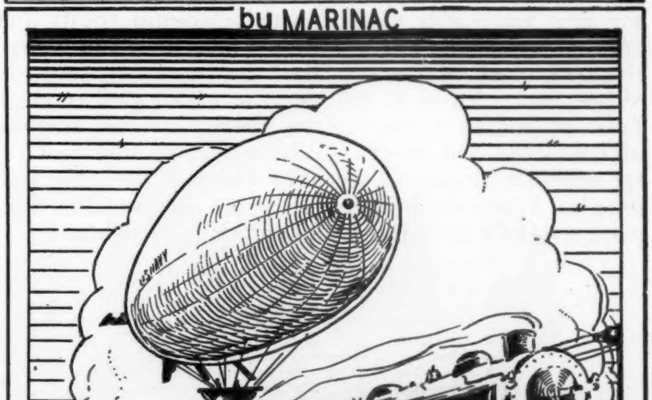
(2) A revival of those essay contests for apprentices which appeared in your magazine a number of years ago.

(3) An annual or semi-annual competition for young engineers, for the design of a piece of railroad equipment to given specifications.

None of the above suggestions involve very large expenditures, but they would stimulate the interest of young men in railroad work and keep them "on edge."

RAIL' ODDITIES

by MARINAC



ARMY DIRIGIBLE LANDED MAIL ON ROOF OF SPEEDING TRAIN AFTER A CHASE OF 35 MILES!

For explanation see page 486

With the

Car Foremen and Inspectors

Painting Railway Passenger Cars*

Part II

By A. M. Johnsen

IN the treatment of car interiors we follow, in designs and colors, contemporary styles. We would not have been able to produce the newer color finishes if it had not been for the development of new and better pigments and liquids. The principal pigments used on these interior finishes are titanium and zinc pigments, and the liquids are treated oils and varnish. The more delicate colors and lighter shades are quite popular. Grain finishes in imitation of wood were very popular for years and are still employed to some extent, but the tendency of the time is toward plain and more delicate colors and away from surplus decorations. The construction material for the interior of Pullman cars is cold-rolled steel sheets, stretcher leveled, and re-squared to specific size. In the mill fabrication, the scale on these sheets is removed by pickling, and the subsequent cold rolling imparts a smooth, uniform surface. We require that this grade of sheet steel be free from imperfections on one side and the best side be marked so that in construction the better surface is applied to face the car interior. The sheets before shipment are oiled to protect them from rust in transit and storage. When these sheets are ready to be applied to the cars, they are first thoroughly cleaned with petroleum spirits and sprayed on the back side with a coat of metal preservative paint, as above described for enclosed sections. When later applied to the car, the whole steel interior finish is sanded to remove the highly-planished surface of the cold-rolled sheets. We then apply one coat of the exterior primer, as we have found it desirable and practical to use one primer both inside and outside. Our paint schedule for interior paint work is as follows:

PAINT SCHEDULE—INTERIOR OF CAR

1st day—Apply one coat primer.
4th day—Apply first coat ground color.
5th day—Putty where necessary.
6th day—Sand.
7th day—Apply second coat ground color.
8th day—Apply third coat ground color.
9th day—Apply first coat of clear varnish.
10th day—Apply ornamentation.
11th day—Apply second coat of clear varnish.
13th day—Apply third coat of clear varnish.
16th day—Rub to desired finish with pumice.

NOTE—If the interior finish is to be grained to match a wood finish, an additional day is allowed for graining applied over the last ground coat. Subsequent treatment is the same.

If it were not for bruises from baggage and the frequent cleaning of the interior required for our high-class service, comparatively little renewal of the interior paint finish would be needed over a period of years. We, therefore, have no general specific treatment for the maintenance of interior paint as prescribed for the exterior. The practice is to be governed by conditions as found and to apply local treatment in sections accordingly, when, where and as needed. This work can be described in shop parlance as spot priming, puttying and cut-in with color and varnish. Men doing this class of work are usually highly skilled in matching so that local treatment areas may not be detected. When necessary, the whole interior finish is sanded down, newly colored and ornamented and revarnished.

Miscellaneous Painting

Other parts of the car require no special decorative coatings, and these coatings are fundamentally for protection purposes only.

In the instance of roofs, galvanized steel is employed, as we obtain considerable protection from the zinc, and, therefore, limited paint protection is required. It has always been more or less difficult to obtain good paint adhesion to galvanized steel. By lightly sanding off the spangled surface, which can be done with negligible loss of zinc, it has been found that a very long-oil primer will adhere satisfactorily. By limited pigment content in this primer, which is composed chiefly of linseed oil with a small percentage of red lead, the primer flows into the minute cavities produced in the surface of the zinc, and gives very good anchorage for the paint. Red lead is desirable for the pigment on account of its basic nature. Over the primer we apply a finish coat of the same type of paint except for the addition of carbon black so as to give the desired black finish to the roof.

On underframes we apply two coats of metal preservative paint and over this one coat of asphalt-asbestos paint, which latter material is commonly known as car roofing cement.

Interior finish on typical Pullman club car

* Abstract of a paper presented by Mr. Johnsen, who is engineer of tests, The Pullman Company, before the Philadelphia Regional meeting of the American Society for Testing Materials, held March 6, 1935.

On trucks we apply one coat of primer and one coat of truck enamel.

While I have in the foregoing briefly outlined Pullman paint practice, that practice is fairly representative of average paint practices of the railways, although on the exterior some few roads prefer flat Japan colors in preference to full varnish color. The latter, however, is most popular. There is used to some extent enamel finishes without the application of varnish over. Enamel coats apply in place of exterior body color as well as interior finish colors. Lacquer has also been employed to some extent. As previously stated, on our cars we have found it preferable to apply varnish as a finishing coat for both exterior and interior. A varnished surface cleans well and gives protection to the decorations.

Paint Materials

The paint materials entering into the railway car paint systems cover a wide range of pigments and liquids. Some coatings are covered by specification and others are preferably handled as approved and tested proprietary coatings. These latter apply more especially to those making up the exterior system, and these coatings are selected on the basis of suitability and cost. They are difficult to cover by specifications due to the fact that many of them have blended liquids, and are so formulated with reference to other coatings comprising the system that we have found it advisable to control such materials as a complete unit comprising the whole paint system. Specifications, however. are always employed where they can be suitably prescribed and controlled on a strictly equitable basis. A coating, by way of illustration, that is impracticable to cover by specification on composition is the Pullman body color. This color can cause considerable difficulty in the paint shop unless accurately formulated and carefully controlled by the color manufacturer, and consequently he requires latitude in the selection and preparation of its raw materials. It is the principal exterior color in use by railroads in this country on passenger-car equipment. There are other colors employed by certain roads which desire a distinct color of their own so as to make it outstanding from the general run of cars. Pullman body color is formulated by an admixture of four or five colors which have to be carefully selected as to shade and physical characteristics, and, unless carefully compounded, there is sufficient separation of component colors when brushed out over the car to produce a streaked appearance, a condition encountered occasionally by all car painters. The condition is more pronounced where the brush splits over projections in the surface such as rivets and overlapping of plates. The color, therefore, requires very careful and uniform application to produce a most solid effect. Shades of this color will vary considerably unless continually held to a master sample.

Railway car paint materials continue to be made chiefly of the older type of oleo-resinous liquids, and the newer synthetic resins are being tried in various coatings. I am not at this time in a position to comment very much on these latter types of materials in railway service since our experience is as yet somewhat limited, but they appear promising due to certain characteristics which they possess. Lacquers are used by some roads, but have not come into any general application for railway car finishing. While the time element in painting new railway cars, as previously referred to, is not as vital as with many other types of equipment—for example, automobile—we nevertheless recognize that quicker drying and harder finishes than those obtained from the oleo-resinous types of materials are desirable and therefore of much interest. They are also of considerable interest on cars undergoing treatment in repair shops where time allowances are usually less than with new cars.

I have briefly outlined our tried and proven paint practice of today. I want to say in conclusion that we are apparently on the threshold of a new era in railway passenger-car construction which is leading into lighter cars. These newer light-weight cars are constructed of light materials, such as aluminums and alloy steels, and it is not unlikely that the paint materials and systems of application, standard of today, may be altered in the future. What may prove to be the best scheme of painting cannot presently be foreseen. It is quite likely, however, that the same underlying principles that guide the practice of today relative to coating will continue to guide future practice, as these principles have been thoroughly tried as to reliability and dependability. So far, our experience indicates that our present regular paint materials are equally applicable to either alloy steel or aluminum. Economic paint application can be truly said to be a test of time in all fields, but it is especially true on railway equipment, and a careful selection of these coatings and their arrangement must be controlled by the best proven practice.

Journal Bearing Protector

Many hot boxes are caused by damaged journal bearings, and in an effort to overcome this difficulty and prevent damage to journal bearings at any time during transit from the repair shop or store room to the point of application, the Louis Bolt & Nut Co., Minneapolis, Minn., has developed the Macer journal-bearing protector, illustrated.

This protector is substantially made of heavy-gage sheet steel and is held in place on the brass by spring clips integral with it. The protector is so designed that it does not contact the bearing surface of the brass and a turned up flange on either end protects the ends of

Macer journal-bearing protector being applied to a car brass

the brass. It can be applied in either direction, with no special care in fitting it to the bearing. A slight finger pressure on the spring clip is all that is necessary to assure easy application or removal.

Complete protection to the brass all the way from the foundry to actual placement in the journal box is said to be possible by the use of the Macer journal-bearing

Conditions which the Macer protector is designed to prevent

protector. When this device is applied, a bearing can be loaded, unloaded, piled, dropped, thrown on and off cars, and otherwise generally subjected to hard handling without danger of marring the soft babbitt surface. These protectors can be used many times over a period of years, their service ending only by serious smashing or bending, which will not occur with reasonable care. They are made in five sizes for the following journals: 4¼ in. by 8 in, 5 in. by 9 in., 5½ in. by 10 in., 6 in. by 11 in., and 6½ in. by 12 in. The initials of the railroad are stamped in the metal for purposes of identification.

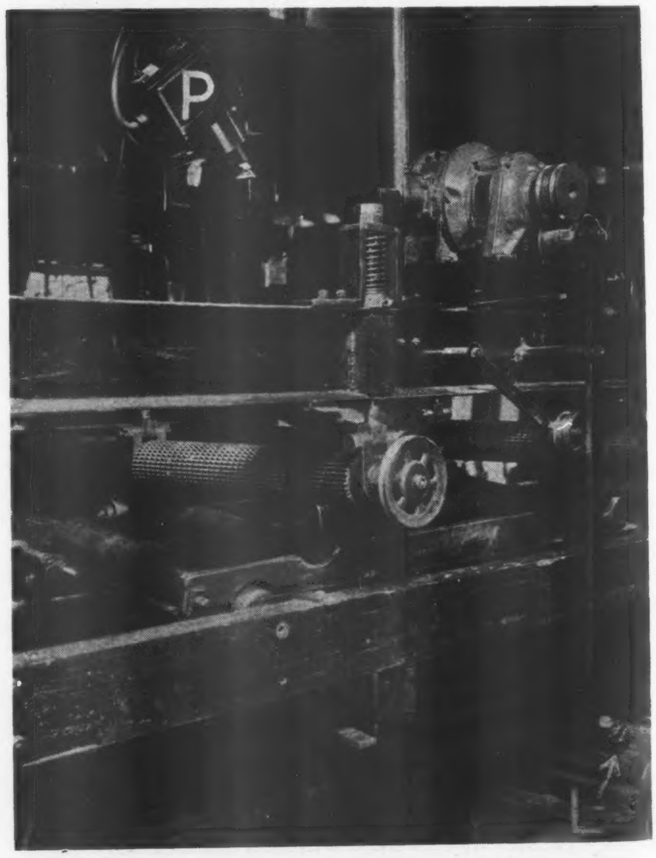
Manufacturing Grain Doors

THE Missouri Pacific, serving the western grain area, is required to furnish the shippers during the harvest and grain-moving period grain doors in quantities, which, when made by hand, have to be manufactured in advance of the grain season and stored in high piles. The development of a modern grain-door plant on the Missouri Pacific at Osawatomie, Kansas, has made possible the application of photo-electric control to one of the principal machines of the plant. In addition to the saving being made in labor costs as a result of modernization of this facility, the rate at which finished grain doors can be manufactured has been greatly increased. The new equipment, costing approximately $33,000, will be paid for out of savings in slightly less than 18 months. Labor costs now are less than one-third of the former expense.

The Missouri Pacific system normally uses from 300,000 to 400,000 grain doors annually, the entire system being supplied from Osawatomie. The former practice of this road was to purchase the lumber to be used during the season and store it near the Osawatomie shops until it could be used. As the grain door plant consisted of little more than a carpenter shop, with power saws and work tables, the actual nailing and fitting was done by hand. Thus, it was impracticable to cut the lumber as used direct from the freight cars, as this would delay release of the cars for other service. However, with the present arrangement, the cars of lumber are spotted at the door of the plant and the boards are unloaded directly on the saw tables with but one handling. This procedure is feasible for the reason that the capacity of the plant has been increased by the recent improvements to approximately 3,000 grain-doors in an eight-hour day.

Operation of the Plant

The lumber to be used in making grain-doors is unloaded from two freight cars at one time by workmen, the boards being laid within reach of two cross-cut power-saw operators. Using adjustable stops for cutting the boards to the proper lengths, these operators saw each piece of stock into two or more pieces. The measured pieces are carried on the stock conveyor tables, which run continuously past each cross-cut saw. The scrap



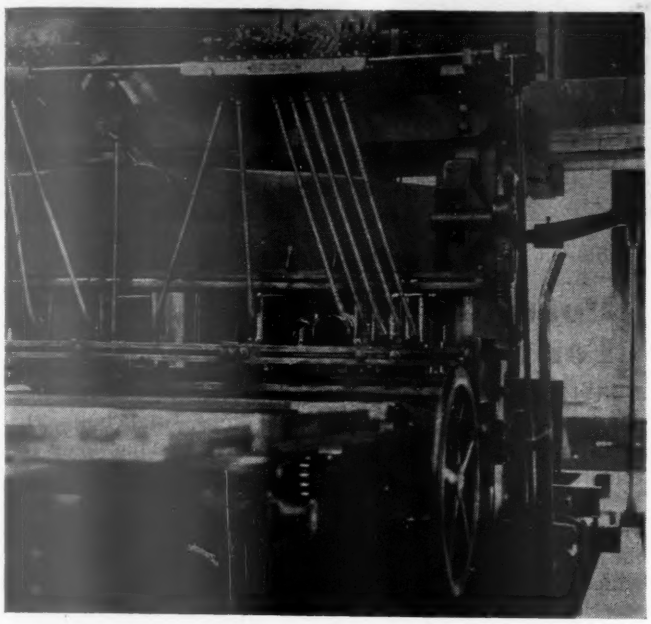
Grain door edging machine equipped with phototube housing *P* and light source *L* for phototube control

lumber is carried outside the building to an elevated bin on another conveyor and loaded in cars for locomotive kindling use.

Between the two stock conveyors is a moving assembly table. The endless belt of this conveyor is fitted with guides upon which the long and short boards are laid in place ready to be nailed. The workmen select the measured boards from the stock conveyors and arrange them in proper order on the assembly table. This moving table delivers the assembled doors to the specially-built nailing machine. This machine, shown in one of the illustrations, is capable of driving 14 nails simultaneously. Controlled by an operator, it drives all the nails in the proper places in a few seconds. The

nailing machine is a product of the Morgan Machine Company, Rochester, N. Y.

From the nailing machine the grain door passes over a roller incline to the edging machine where it is received on a roller and is fed automatically through the edging saws, which true the lengthwise edges and a roller cuts "M. P. R. R." in several places. The finished door is



Morgan 14-lead nailing machine set up for nailing grain doors

received by a moving conveyor which carries it outside to the storage area where workmen arrange the finished doors in large stacks, or directly into cars for shipment. A portable conveyor facilitates this work of stacking finished doors.

Phototube Controls Edging Machine

The edging machine mentioned in the previous explanation is controlled by the photo-electric equipment. One of the accompanying illustrations shows the roller platform of this machine, which receives the nailed door from the nailing machine. In the lower portion of this illustration the light source *L* may be seen and diagonally above it the phototube housing *P*. Also in the lower portion of this photograph the General Electric Type M-3 600-lb. Thrustor appears.

As each grain door falls on the roller platform, it interrupts the light beam shining from below. The photo-electric relay equipment in turn actuates the Thrustor *T* which raises the roller platform to engage the door in the toothed roller, which feeds it through the edging machine. After the door passes beyond the light beam the Thrustor is automatically released and the roller platform is in position to receive another door from the nailing machine. The edging machine formerly required an attendant.

The General Electric Thrustor is of the hydraulic type, using oil as a medium and a ½-hp. induction motor for operation. The photo-electric equipment is also of the General Electric manufacture; the light-sensitive element is a PJ-23 phototube. This tube is of the two-electrode central-anode type and is gas filled. The active surface of the tube is caesium deposited on oxidized silverplated copper. Argon gas is used to produce ionization which augments the primary electron emission. The tube requires an anode potential at a maximum of 90 volts. It operates a GEH-913 midget photo-electrical relay. The light source is a 6-8-volt lamp.

Other Electrical Equipment

The total connected load of the entire plant is approximately 100 hp. All of the motors are of General Electric or Wagner Electric manufacture and those on the conveyors are fitted with suitable reduction gears. The motors range in size from the ½-hp. Thrustor motor to the 20-hp. blower motor, which serves to exhaust the sawdust to an incinerator outside. The five conveyor motors are of 3-hp. rating each.

The normal power demand while the plant is working at full capacity is less than 50 kva. The energy is received over the company-owned shop distribution line at 2,300 volts, 3 phases. A transformer station outside reduces this potential to 230 and 115 volts; the secondary circuit consists of three 250,000 C. M. conductors. The electrical energy is purchased by the railroad from the local municipal power company on a flat kilowatt-hour rate.

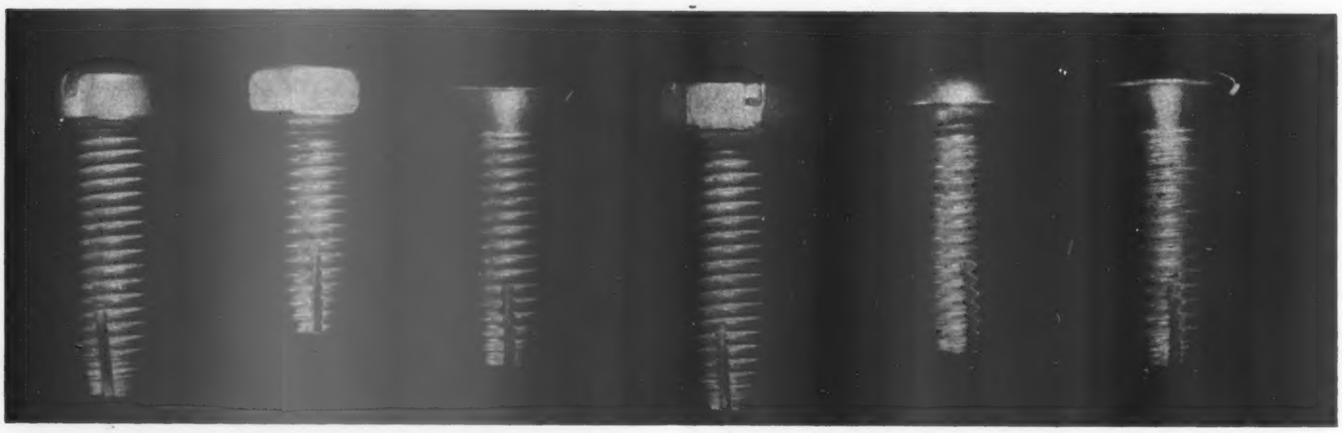
Pyle-National safety switches are situated at several motor stations to facilitate operation and to provide the necessary fuse protection. All secondary wiring, excepting the main feeders, which are on service racks, is in conduit. The special controls for the photo-electric equipment are mounted on a panel above the nailing machine.

Self-Tapping Screw

A SELF-TAPPING screw with standard machine-screw thread, produced by the Shakeproof Lock Washer Company, Chicago, is now being extensively used on a number of roads to simplify assembly problems and to substantially reduce the time and cost of many equipment-maintenance and construction jobs. It is designed to eliminate a costly tapping operation and provide an accurately fitting, hardened screw with standard machine-screw thread.

Due to the exclusive "Spring-Action" slot, machined in its tapered end, this screw cuts its own thread, and, regardless of the thickness or type of material used, it drives in easily and provides a normal thread engagement which assures the necessary holding power. The material it cuts is directed into the Shakeproof slot,

Applying car interior sheathing and trim by the use of Shakeproof tapping screws



Typical standard machine screw heads available on the Shakeproof tapping screw

away from the cutting edge, which means a clean-cut thread and easy, fast driving.

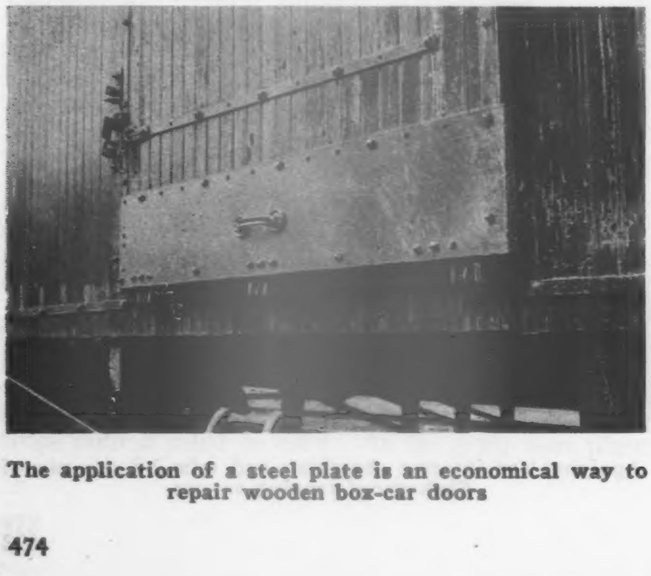
The Shakeproof tapping screw is said to have shown great adaptability and value for such interior work as applying trim, insulation strips, seats, hardware and electrical fixtures. It is available in standard machine-screw heads and sizes, six of the heads more commonly used being shown in one of the illustrations. The other view illustrates the ease and convenience of applying interior sheathing and trim in a passenger car by its use.

Plating Box Car Side Doors

THE plating of box-car side doors as shown in the illustration has been adopted by one railroad on all wooden box-car doors that pass through the shops. Usually the first part of the side door to become defective is that portion which is shown plated. This is due largely to trucks backing into the doors or by the use of bars employed by unloaders at freight stations or on team tracks.

These plates are made from shearings from larger plates in the fabrication shop and their limited size makes them unsuitable for use in other repairs to cars. Plates of one-quarter to three-eighth inch thickness are used and are painted the same color as the body of the car. For this reason they are not particularly noticeable after the cars leave the shop.

In addition to providing such protection as above mentioned, the application of these plates serve as a brace for the door and prevents weaving.



The application of a steel plate is an economical way to repair wooden box-car doors

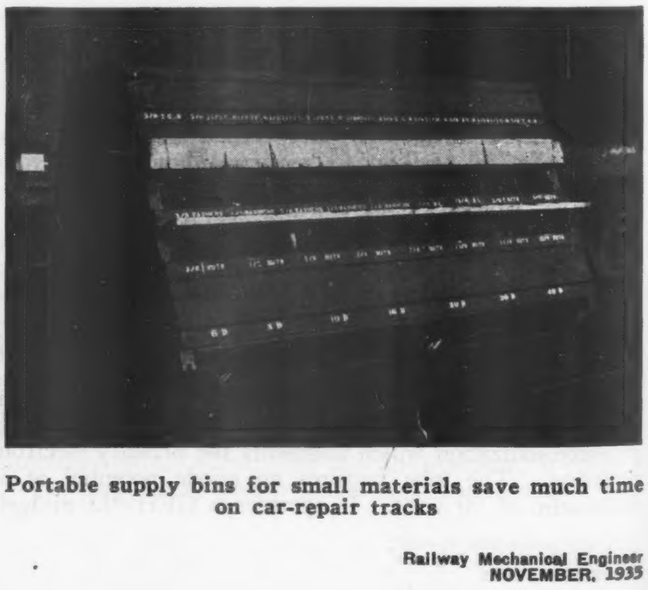
Portable Supply Car For the Repair Track

THE problem of supplying miscellaneous small items such as nuts, washers, cotter keys, small bolts, etc., to car repairmen on the light repair tracks has been one that has caused no little concern to many shop foremen. If such items are supplied by the regular material men there is usually a surplus that must be gathered up at the close of the day. If the mechanic leaves the car on which he is working to draw such material from the storehouse there is a considerable loss of time in traveling to and from the storehouse.

The portable supply car shown in the illustration was designed by one car foreman and seems to meet the requirements for supplying such items to the light car repair force. The car is moved up and down the material supply track and only sufficient material is taken from the bins by the mechanic to take care of the immediate repair job on which he is working.

The material bins are mounted on a four-wheel truck. It is approximately eight feet in length and is provided with a sufficient number of bins to take care of the material requirements, doors being provided on both sides to facilitate the securing of material. At the close of the day the doors are closed and a piece of ½-in. by 2-in. strap iron, attached to the top of the bin with a staple is fastened and locked at the bottom with a repair track lock thus preventing the doors from being opened and material removed.

A stencil is provided under each bin to indicate the size and character of the material that it contains.



Portable supply bins for small materials save much time on car-repair tracks

In the

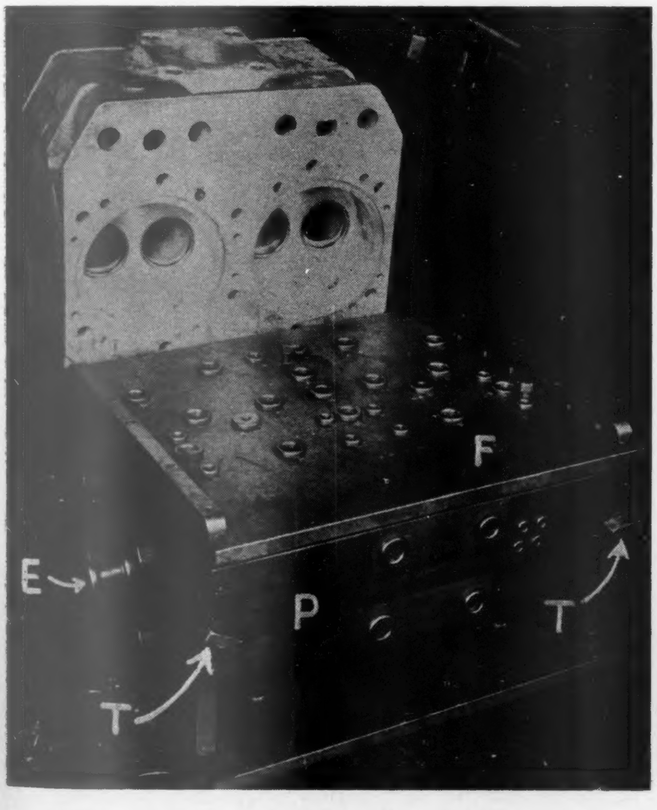
Back Shop and Enginehouse

Machining Two Internal-Combustion-Engine Parts

NUMEROUS special holding fixtures for use in machining various internal-combustion-engine parts have been developed and are now being used at the Silvis (Ill.) shops of the Chicago, Rock Island & Pacific. Two of the most interesting are those, illustrated, for machining 8-in. aluminum-alloy pistons and the drill jig, which is used for drilling all except the angular spark-plug holes in cylinder heads, or combustion chamber heads as they are sometimes called.

The construction of the fixtures used in machining the pistons is clearly shown in the illustration. The special fixture *A*, at the left, is designed for use in machining the cylindrical surfaces of the piston and the ring grooves. The bracket fixture *C*, at the right, is used for boring the wrist pin hole, accurately in position and square with the center line of the piston. The roughing and finishing multiple grooving tools, shown at *B*, are designed to cut all ring and oil grooves, properly spaced, at one time.

In machining a piston, the first operation is to place the rough piston casting in an 18-in. engine-lathe chuck and face off the skirt end slightly, also boring and counterboring, as called for in the drawing. The skirt end of the piston is then placed over the centering boss on fixture *A*, the piston being held firmly against the centering plate by means of a 1¼-in. draw bolt having a hole in one end to accommodate an undersize wrist pin and a 1¼-in. nut (not shown) on the other end. As soon as the piston is suitably secured in the fixture, the latter is centered on the engine-lathe face plate and the outside diameter of the piston rough-and-finish turned the full length, with a slight allowance of stock for finish grinding. The head of the piston is then faced off to give the required piston length. The ring and oil grooves are machined at one time, using the roughing and finishing multiple grooving tools *B*. In cutting these grooves, the multiple tool holders are bolted (one at a time) on the compound of the lathe carriage, using two 2¾ bolts (not shown). The double set screws used



Drill jig used in drilling internal-combustion engine cylinder heads

Holding fixtures used in machining internal-combustion engine pistons

in holding the multiple tools in place in each holder are clearly shown in the illustration.

The piston is then removed from the fixture and placed with the same skirt end in the centering plate in fixture *C*, being securely held against this plate by means of two ⅝-in. bolts and a light crossbar. (The latter has two small copper strips soldered in place on the under side to contact with, and protect, the finished piston head.) The centering plate is, of course, square with the back of the bracket fixture which can be quickly and accurately centered on the lathe face plate by means of a boss extending through from the dummy wrist pin, illustrated. A boring bar and cutting tool are used to bore the wrist-pin hole which is machined to within .002 in. of the specified diameter and then finished by a hand expansion reamer. It is apparent that by the use of this fixture the wrist-pin hole is automatically spaced the correct distance from the piston head and square with the cylinder bore.

The final operation in machining the piston consists of finishing the outer diameter on a cylindrical grinding machine, this size being held within a limit of .0005 in. On a job lot of 29 pistons, the production time, using

this method of machining, averaged a little over three hours per piston.

Drilling Internal-Combustion-Engine Cylinder Heads

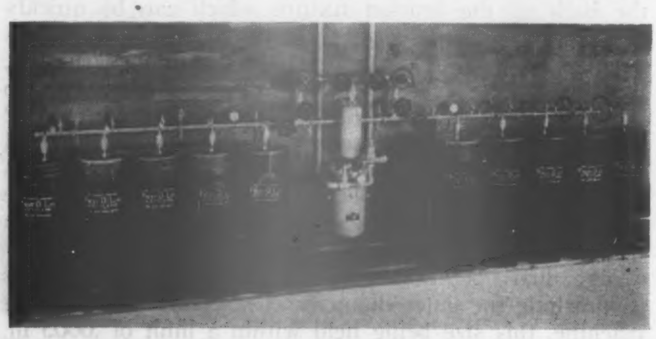
The drill jig, shown in the second illustration, is used to complete practically all drilling operations on a gas-engine cylinder head, with the exception of the angular spark plug holes. The jig is made of open-hearth steel plates, accurately positioned with respect to each other by means of dowels and firmly held together in a box-like construction with cap screws. Two strips of 7/8-in. cold-rolled steel stock are applied to the upper edges of the jig, and two to the lower, to provide bearing surfaces, clear of all bushings and cap screw heads when the jig rests on the drill table on the floor. These bearing strips are, of course, held in place by flush fillister-head screws. The jig is equipped with properly-sized and hardened positioning bushings for all holes, the size of each hole being stamped on the plate adjacent to the bushing for the information of the drill operator.

In applying a cylinder head in this jig, the front plate *P* is removed by loosening the two thumb screws *TT*. This can be done quickly and the head inserted in the jig, being accurately positioned over two rings on the bottom plate which fit into the combustion chamber holes and resting on four 1¼-in. supporting plugs which extend about ¼ in. above the lower surface of the jig to give chip clearance. Three set screws in the top plate *F* of the jig serve to hold the head firmly against the bottom plate, the points of these set screws being equipped with special swiveling contact rings to avoid marring the finish. Plate *P* is then reapplied and the jig taken to the drill press for subsequent drilling operations. The work of handling this jig on a jib crane and revolving it, as needed for drilling operations on the various sides, is greatly facilitated by means of a double hook arrangement which engages two posts on the end plates of the jig, one of the posts being shown at *E*.

Acetylene Cylinder Manifold

A NEW wall type acetylene cylinder manifold, Oxweld Type M-8, is announced by the Linde Air Products Company, New York. It is available in a ten-cylinder unit to which extensions in units of five or ten cylinders can be made. This manifold consists of two high-pressure header units which feed into a central regulation system and delivers acetylene to the shop piping system at pressures up to 15 lb. per sq. in.

The header unit assemblies are composed of heavy seamless steel tubing with forged steel union connections



Oxweld Type M-8 wall type acetylene cylinder manifold

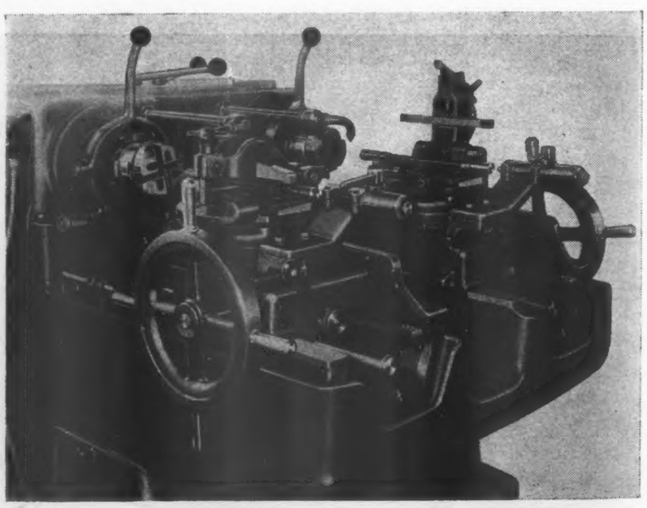
having stainless steel seat inserts, the valves for cylinder connections being threaded directly into the steel tubing header. Connections from the header valves to the cylinder valves are made with flexible leads, coiled to provide sufficient flexibility, fitted with a flash arrester, and provided with a ball check. This guards against the possibility of acetylene from the header being driven back into an exhausted cylinder. The two high-pressure header assemblies are connected by forged steel unions to a central system of six valves and two regulators for controlling the operation of the manifold.

The pressure in each header is indicated on a high-pressure gage located on the headers near the union connections to the regulator assembly. A low pressure gage, attached to the outlet of the hydraulic back-pressure valve, indicates the delivery pressure to the shop piping system.

Work Alining and Indexing Fixture

THE Landis Machine Company, Waynesboro, Pa., has developed a fixture for application to its Landmaco threading machines for threading parts which have a thread on each end and require alinement and concentricity of both threads. In addition to providing for alinement, the fixture also indexes automatically so that both ends of the forging or bar can be threaded with one gripping.

The forgings are centered and the surfaces to be threaded turned previous to the threading operation. With the work resting on a ground "Vee" block at the front end and the rear end alined with a center, the operator drops a self-compensating clamp on the work

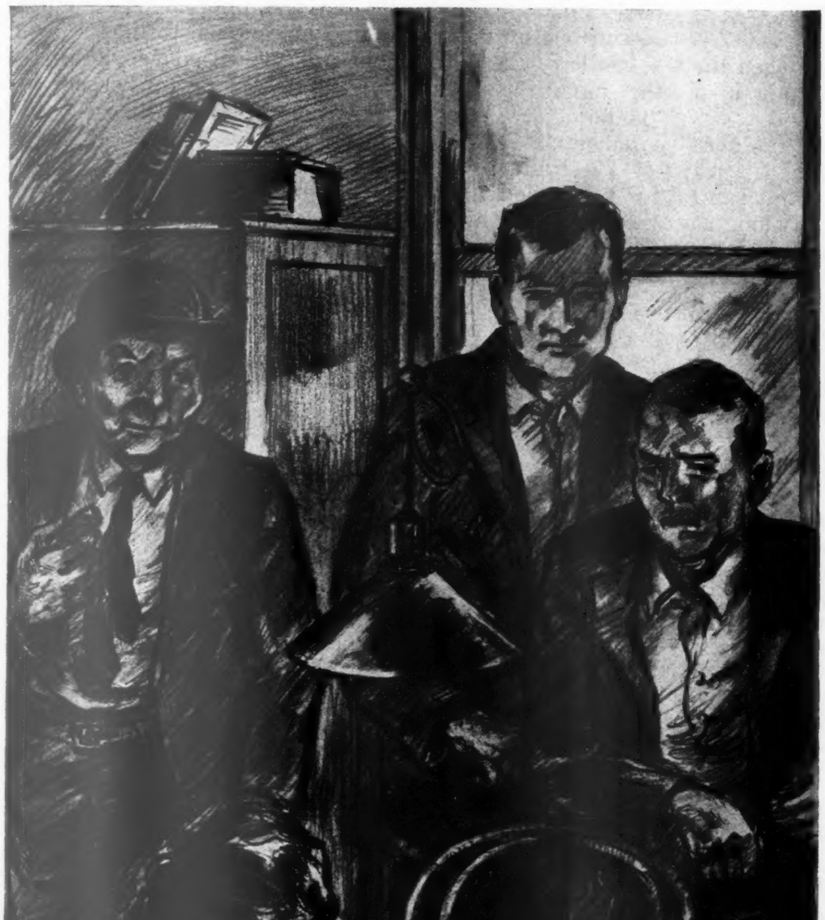


Landis Landmaco threading machine with alining fixture for cutting threads on both ends of a bar

to hold it in position. A compensating wedge, actuated by the clamping device, moves over under the pad forged integral with the bar, seating the bar firmly and maintaining the alinement established by the center.

Upon completion of the first thread the carriage is withdrawn by means of the hand wheel, the backward movement of the carriage automatically indexing the work holding fixture 180 deg. A lock bolt automatically locks the fixture in position after each indexing. In this manner both ends of the work are threaded in one gripping.

NO MORE ENGINE FAILURES



Master Mechanic Carter of the Plains division, S. P. & W., glared at the three foremen as if waiting for an answer and daring them to open their mouths

by
Walt Wyre

"ENGINE failures must be reduced. If they're not, there's likely to be some new faces around here. Eleven failures last month, four already this month, and less than a third of the month gone. It's a disgrace!" Master Mechanic Carter of the Plains Division, S. P. & W., glared at the three foremen as if waiting for an answer and daring them to open their mouths.

Sam Crabtree, the general foreman, cleared his throat uneasily. Jim Evans, roundhouse foreman, bit off a hunk of "horseshoe" and edged over towards the cuspidor by the side of the master mechanic's desk. Parker, the night foreman, broke the silence.

"I remember when I was on the Big Four——"

"We're not talking about the Big Four," the master mechanic interrupted. "What I'm interested in is the S. P. & W. and especially the Plains Division. How are we going to stop engine failures? Look at this—hot main pin, broken radius rod on valve gear, hot trailer box, broken main axle!"

"But that main axle broke right up in the wheel fit. How are we going to prevent that kind of failure?" Crabtree asked.

"That's not the kind I'm talking about. How about hot pins? How about that broken main rod on the 5084? An old crack in it half way through—that's the kind I mean!" Carter's voice made the windows rattle like a drumming oil burner being fired in the room.

"What do you say, Evans? You're in the roundhouse where the work is done —or maybe it's not done—anyway, what's your opinion?" The master mechanic lowered his voice so that it could only be heard about a block away.

The roundhouse foreman was caught unaware. He expectorated a copious stream of tobacco juice and wiped his mouth with the back of a hairy hand before replying. "Well, I can't exactly say. Looks like everybody's doing all they can. If we had a few more men——"

"We can't get any more men; that's out of the question. If we can't stop engine failures with what men we have, somebody will take our places that can. It's just a matter of seeing that everything needed is done and every job done right."

"That's just what I say, Mr. Carter. When I was on the Big Four——"

"That will be all for the present, and

remember, no more engine failures that can be prevented." The master mechanic concluded the meeting.

That night Evans dreamed of hot pins, broken rods, and cut journals. The Limited was just pulling out when a driver tire came off with a crash and a clatter. He jumped out of bed and shut off the alarm clock that had interrupted the nightmare.

EVANS was looking over the line-up book when the seven o'clock whistle blew. Crabtree came in a few minutes later.

"Well, what does it look like this morning?" the general foreman asked.

"Not so good. The 5079 came in hot all over, water on two tank brasses; the 2806 has a work report long as the well-known dream; the 5094 lost two hours because the water pump wouldn't supply the boiler; and the 5088, according to the engineer's report, is pounding all over, cylinder packing blowing, lame on one side, and won't steam."

"Who came in on her—Harrison?" Crabtree asked.

"Uh-huh," Evans replied as he gathered up work reports and slips.

By eight o'clock, work reports were in the metal cases that hung on the roundhouse wall in front of the various engines. Work slips were distributed in pigeon holes, each of which bore the name and classification of a mechanic. The board showing when engines were to be used, etc., was marked up and another day begun.

After the work was lined up, Evans went out to the machine shop. A stack of unfinished brass bushings, a pair of valve bushings still in the rough, and a piston rod to be turned flanked an idle lathe. Machinist Roy Henderson was dismantling the gear box.

"How you coming on the bushings for the 2810?" Evans asked.

"Not so good," Henderson replied. "Another gear stripped in this blamed lathe. Why don't they get some new gears?"

"They've been ordered a long time, but the company that built the lathe has quit. Hard to get parts," the foreman explained.

"Yeah, that's what comes of buying bastard machines. I've put in more teeth in the last six months than all the dentists in town. It's too light for this heavy work, anyhow," Henderson growled.

"Well, get it going soon as you can." Evans bit a corner off a plug of "horseshoe" and headed for the office. He was stopped by Paul Sanford, the outbound inspector.

"There's a crack in the combination lever of the 5093," the inspector told him. "She's called for nine o'clock."

Evans swore softly and went over to look at the engine. "Aw, that's not a crack, it's just a scratch," but his tone wasn't convincing.

The inspector wiped the place with a piece of waste, then rubbed chalk over it. He hit it several sharp blows with his hammer and a hairline of grease appeared on the chalked surface. No more engine failures the master mechanic had told him the afternoon before! Not another engine ready and none that could be made ready in a reasonable length of time.

He could have the blacksmith forge the defective metal, but by the time it was taken off, forged, cooled and replaced, that would mean a serious delay, and he'd have to answer for that. On the other hand, it was a very small crack. Maybe it would make it. If it did, no one would be the wiser. If it didn't. . . . Time enough to think about that after it had broken. He made a note to have it fixed up the next time the engine came back to Plainville.

The general foreman was looking over the morning mail when Evans entered the office. The foreman told Crabtree about the cracked combination lever.

"Guess that was about all you could do," the general foreman replied. "Here's a pretty hot letter about using too much material, especially brass," he added.

"Can't help it, with pins out of round and driving boxes pounding like a pile driver and not enough engines to run one over the drop pit long enough to fix it."

Rattle of the office phone interrupted conversation for the moment. John Harris, the clerk, answered it. "Hello . . . Yes . . . Wait a minute, I'll ask the foreman . . .

"The train delayer wants to know if he can get a 2800 for two o'clock, hot-shot freight."

"I'll talk to him." Evans reached for the telephone. "All right, Evans talking. Do you want a booster or non-booster?"

"If you got a non-booster in good shape, that would do, unless they pick up six cars of stock at Wister; then we'd better use a booster," the dispatcher told him.

"When you make up your mind, let me know," the foreman told him and hung up. "Be back in a little while and let you know," he told the clerk.

THERE were only two 2800's that could be gotten ready by two o'clock except ones that were to be used on regular trains. The 2854 had a booster; the 2811 didn't. The rods were down on one side of the 2854 and the pistons were out of the 2811. Evans marked up both engines for two o'clock and told the machinists to get them done.

He went up to the drop pit to see how the 2857 was coming along. It was better than he had expected. Machinist Reynolds and his helper were checking the valves. The electrician was replacing cab globes that had been taken out; coppersmiths were finishing the pipe work in the cab; and the painter was striping the tires. The boiler was full of water and the fire builder was waiting for the coppersmith to connect up the oil-burner atomizer pipe so he could get the engine hot.

On the next pit, Machinist Jenkins was filing a rough main pin on the 5077. "Think you can save it?" Evans asked.

"I don't know," Jenkins told him. "It's a long, slow job; besides, it's out of round nearly an eighth of an inch."

The foreman spat reflectively, shifted his cud of "horseshoe" to the other cheek and went out to the machine shop. Henderson had repaired the broken teeth in the lathe gear by building them up with brass and filing to shape. The lathe sounded like a Shea locomotive running through a cut, but Henderson was making the brass fly.

Machinist Fuller was taking a light cut on a valve bushing in the big belt-driven lathe nearby. The foreman watched a moment and walked over. "That the last cut?"

"No, but it's all I can take. The clutch slips if I try to take more—wore out."

Evans went back into the roundhouse to see how the 2800's were coming. Both seemed to be in good shape and smoke was pouring from the stack of the 2857.

"Well, guess I'm ready for old guess-and-growl," he told the clerk a few minutes later. "If he wants a booster engine it'll be the 2854; if not, give him the 2811."

The dispatcher called while Evans was in the office and told him they'd have to use a booster, picking up eight cars of stock at Wister.

Things went along very nicely until just before noon. The 2854 was about finished. Machinist Long spun the nut on the number four crank pin with his fingers

"Another gear stripped in this blamed lathe. Why don't they get some new gears?"

and was tightening it with a wrench. He gave a heave and staggered back as the nut suddenly turned easily. He tried again, and the nut slipped. He removed the nut. The threads were stripped almost smooth on the crank pin.

"Well, I hate to use an engine right off the drop pit without breaking it in on a slow run, but guess we'll have to take a chance," the foreman said when Long told him about the stripped threads on the crank pin. "Find the hostler and tell him to get the 2857 out; I'll run it up and down the lead to limber it up a bit."

It was eleven-thirty when the hostler ran the engine out on the lead, after taking oil, water, and sand. Evans climbed on the engineer's seat, opened the bell ringer valve and reached for the throttle. Rhythmical exhausts as the engine picked up speed told of valves that were square. Evans closed the throttle as the engine approached a sharp curve in the track. A screeching protest came from the engine as it rounded the curve. He thought at first it was wheel flanges crying, but the sound wasn't high pitched enough. He stopped the engine and climbed down to look it over. Not enough lateral on the main driving box.

"Run this damned engine back over the drop pit," he told the hostler, and rushed back to the roundhouse office.

Evans explained the predicament to the general foreman. "Well, it looks like we're up against it, all right. Maybe he would take a 5000."

"Might if we had one, but we haven't got it. I'll rush back from lunch and see if I can't dope out some way," Evans said as the whistle blew.

When Evans returned from lunch, he went out to look the 2854 over. He picked up the crank-pin nut and screwed it on the loosely fitting threads. Absent-mindedly he fished in his coat pocket for the inevitable cut of "horseshoe." When the prodigious chew was satisfactorily masticated and stowed in a bulging left cheek, he again fingered the crank-pin nut.

"I might get away with it." Evans spoke his thoughts aloud.

When the one o'clock whistle blew, he found Long. "Get a cutting torch down to the 2854; burn a hole through the crank pin and put a one-inch bolt through it."

"You mean lengthwise through the pin?" the machinist asked.

"Yes, and don't burn the pin all out doing it. I'll have a washer made to fit up against the crank-pin nut. Double nut the one-inch bolt and get it soon as you can." Evans headed for the machine shop. After instructing Henderson to make the washer, he went back to the office.

"Well, I hope I'm getting the 2854 O. K. It's a chance, though," Evans told the clerk.

"Don't need it now; the dispatcher changed his mind; wants a non-booster, and it'll be three-fifteen; 82 will pick up the stock at Wister," the clerk replied.

"Well, I'll be damned!" the foreman ejaculated, and started back to tell the hostler to get the 2811 out and head it east.

The rest of the day passed without untoward incident.

NEXT morning, there was a wire on the general foreman's desk from the master mechanic. Crabtree handed the pink slip to Evans without comment: "Train No. 10 delayed three hours Sanford, broken combination lever engine 5093. Old break. Take in-

spector responsible out of service. Will hold formal investigation."

"Well, the inspector found it, all right. Guess I'm the goat," Evans commented morosely.

"It's not entirely your fault. I'm in it, too," Crabtree told him. "We've just got to quit taking chances like that."

"Yeah, and when we do we'll quit running trains unless they give us more machinists—or some tools to get the work done with," Evans added as an afterthought. "And I'm going to tell him so when he holds the investigation on the 5093. When will Carter be back?"

"Day after tomorrow, I imagine. Wouldn't be surprised but what he lets us know when he does get back."

Evans carried a scratch pad and pencil in his hand most of the time the next two days. A wave of apprehension swept over the men in the shop. Backhouse talk had it that the foreman was taking names of every one caught loafing.

"I—I'm waiting for a side rod bushing," one machinist told Evans when the foreman came by with the scratch pad in his hand.

There was another wire from the master mechanic next day: "Supt. of Motive Power, W. R. Butler, will be in Plainville, Wednesday 11th. Arrange meeting all foremen in my office three P. M."

"Just right!" was Evans' comment when he saw the message.

"Just right for a couple of foremen to go on relief! I can see myself on a working foreman's job somewhere in the sticks right now." Crabtree didn't share the roundhouse foreman's optimism.

"WHEN I was foreman on the Big Four, we didn't know what a failure was. Why, I remember one time——"

"I see Parker got here first," Evans remarked sotto voce to Crabtree as he shoved the door open.

The atmosphere was tense in the room. Butler shook hands with the two men somewhat stiffly, then nodded to indicate vacant chairs.

"Where's that failure sheet?" Butler asked the master mechanic by way of beginning.

"Men, performance on this division the past few months has been disgraceful. Eleven failures last month, five already this month. Costs of those failures will run close to a thousand dollars each, to say nothing of lost business. I can't explain such railroading; I hope you men can." Butler paused for a reply.

"Well," Crabtree began nervously, "you know, Mr. Butler, eleven hundred miles is a long ways to run an engine, and——"

"Other roads are doing it!" the superintendent of motive power interrupted. "What about that failure on the 5093? You can't expect a locomotive to make it going out with a combination lever broken half way through."

Evans half rose from his chair. "I can tell you what the trouble is," he said somewhat defiantly.

"That's what I want to hear."

The roundhouse foreman's hands trembled slightly as he pulled a sheaf of papers from his coat pocket. "The trouble is we're paying about eight mechanics to do nothing!" Evans blurted.

"It's your job to see that they keep working," Butler snapped.

"They do keep working, but——"

"I haven't got time to listen to riddles. If you can explain, go ahead."

"If you'll just give me a little time, I will." Evans' anger overcame his nervousness. "What I mean is this, we need some tools so the men can do something when they work."

"We have no money to buy tools. It's hard enough to meet the payroll."

"Yesterday a machinist and helper put in six hours filing and smoothing a rough main pin. They done a good job—good as could be expected the way they had to do it—but the pin was still out of round. We could save enough on bushings in two months to buy a pin turning machine. That would cost nothing, in the long run, I mean; besides, it would give the machinists time to do other work.

"Last month we lost at least two mechanics' time every day waiting on machine work. And I figure another man's time was lost on account of being able to not turn out as much work in the machine shop with the equipment."

"Why don't you fix them up? Order new parts!"

"That ain't the trouble. They are not suited to the job. For example, the small lathes won't stand up on the large bushings for the engines we have now, and the big lathe is too slow. It'll do for turning pistons and such work as that."

"What else?" Butler asked.

"We need an emery wheel in the roundhouse."

"I guess you're going to tell me the one in the machine shop is out of date."

"No, it's all right, but by the time fifteen or twenty men put in ten or fifteen minutes a day walking to the machine shop to sharpen a chisel or grind the burr off a pin and a dozen other things, it amounts up."

"What's all this got to do with the broken combination lever on the 5093?" Butler asked somewhat sharply.

"Well, the men could have had the work done on other engines and I wouldn't have had to take a chance with the 5093." Evans sat down.

"Why didn't you tell me all this?" the superintendent of motive power asked the master mechanic.

"I believe I did tell you we needed some equipment, needed it very badly," Carter replied.

"Well, you didn't tell me how much it is costing not to have it," Butler replied. "Make a thorough check and let me know. And now about these engine failures——"

Combination Test Rack

A COMBINATION test rack, recently installed at the Silvis (Ill.) shops of the Chicago, Rock Island & Pacific, is designed to be used in testing both air compressors and feedwater-heater pumps and give them a thorough break-in before being applied to locomotives undergoing general repairs in the shop. The principal advantage of this arrangement is that it gives a positive check of the performance of these important locomotive parts and avoids the possibility of having to remove them for defects or unsatisfactory performance, perhaps even before the locomotives go into service. Another advantage is the concentration of test work at one point in the shop adjacent to the respective repair departments where the test work can be carried out under the necessary supervision.

The air compressor test rack, shown rather indistinctly at *A* in the illustration, is designed to accommodate Westinghouse 8½-in. cross compound and 9½-in. single stage compressors, also New York No. 6 compressors, the holding bracket being provided with neces-

sary spacing bars and drilled holes to accommodate these different sizes and types of compressors. The steam supply is from an overhead steam pipe and the exhaust is connected to an exhaust line in the floor. Compressed air passes to the overhead cooling coils and air reservoirs shown. The necessary flexibility in steam and air-pipe connections, required in applying different air compressors to the test rack, is provided by Barco flexible metallic joints. An hydrostatic lubricator provides oil for the steam cylinders while breaking in, and particular care is exercised to make sure that the air cylinders, also, have enough, but not too much, lubricant. All standard air-compressor tests are made on this test rack.

The equipment for testing feedwater-heater pumps is clearly shown in the illustration, a Coffin pump being located at *B*. The sheet-metal water-storage tank is approximately 4 ft. by 4½ ft. by 6 ft. in size. From near the bottom on one side, a 4-in. pipe extends horizontally direct to the water intake of the Coffin pump, and a branch line is piped into and under the floor to the flexible reinforced rubber hose at *C*, which is the position for testing Worthington pumps. Both pump outlets are piped to a line which feeds back into the top of the tank through a valve which may be partially closed to develop any desired pressure. Suitable steam inlets and exhaust lines are piped to the pumps, and the necessary steam and water valves are provided, having extension handles which bring the controls within easy reach. Hydrostatic lubricators are installed to furnish lubrication to the steam heads and gages show the steam pressure, water pressure and orifice pressure.

When testing one type of pump, connections for the other type are, of course, cut out, as the test rack is designed with but a single tank and water circulation system. A rigid steel frame work, provided at *C* to support the different types of Worthington pumps, is made of two 6-in. steel channels set in cement blocks in the shop floor and connected at the top by two 1-in. by 6-in. cross bars. Steam and water connections are made by means of Barco joints and the usual threaded and flanged joints, shown. The same man who tests the Worthington heaters also makes air compressor tests, being a specialist in this work. Another man with equally specialized experience makes all of the tests of the Coffin heaters.

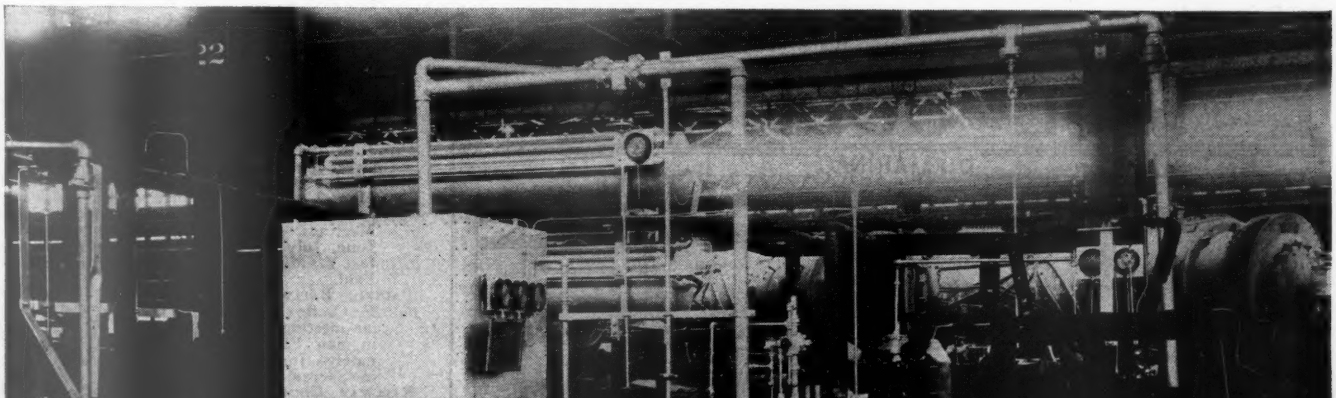
Standard exhaust-steam-heater tests are made on this rack and prove very effective in checking the quality of the shop repair work, any defects being detected and corrected before the heaters are applied to the locomotives. This is particularly important in view of the large amount of work involved in handling heavy heaters and making or breaking numerous large pipe connections every time a heater is applied to or removed from a locomotive.

By having highly-specialized mechanics handle the various types of heaters, difficulties encountered in average roundhouse maintenance are almost eliminated. Thus, the overhaul cost, as well as the material cost, is reduced by keeping the repair work centralized at one point. Pumps reconditioned by this method usually stay intact on the line of road for a long period and quite frequently from shopping to shopping, with no other maintenance except the usual necessary scaling or cleaning.

"Certainly Cow-Catchers Catch Cows," Says Willard

The Baltimore Evening Sun recently ran this item: "The Evening Sun editorial writer grows lyrical over the presence of a cow-catcher on the new engine of the Baltimore & Ohio's Abraham Lincoln. Well, we have been familiar with railroading all our lives and have made a special study of cow-catchers. And if we were a movie critic we would offer a blue ribbon with palms to any person who could cite one instance in the whole history of railroading in which a cow-catcher actually caught a cow."

Daniel Willard, president of the Baltimore & Ohio, and a former engineman, took exception to the item. When a reporter from the journal called upon him, he cited numerous instances out of his own experiences and so thoroughly convinced the reporter that not only the Sun, but many other newspapers throughout the country published his proof that the locomotive pilot is there for a very good purpose.



Combination test rack used to test and break in air compressors and feedwater pumps before application to locomotives

Among the
Clubs and Associations

Car Foremen's Association of Chicago.—The annual meeting of the Car Foremen's Association of Chicago was held Monday evening, September 9, at the La-Salle Hotel, Chicago. At the close of a brief business session conducted by President E. Mazurette, car foreman, Grand Trunk Western Lines, Chicago, the following officers were elected for the ensuing year: President, C. O. Young, chief clerk to superintendent car department, Illinois Central, Chicago; first vice-president, J. S. Acworth, supervisor of equipment, General American Tank Car Company, Chicago, and second vice-president, F. A. Shoulty, general car foreman, Chicago, Milwaukee, St. Paul & Pacific, Chicago. The treasurer and secretary were continued in office, the treasurer being C. J. Nelson, superintendent, the Chicago Car Interchange Bureau, Chicago, and the secretary, Geo. K. Oliver, assistant passenger car foreman, Baltimore & Ohio Chicago Terminal, Chicago.

American Society of Mechanical Engineers.—Sessions on Psychology (Symposium on Effect on Human Relations of Technological Changes), Compensation Laws, Occupational Diseases (auspices A.S.M.E. Safety Committee), as well as the regular sessions of the Railroad, Fuels, Power, Applied Mechanics and other divisions of the American Society of Mechanical Engineers, will feature the 1935 annual meeting of the Society to be held at the Engineering Societies building, 29 West Thirty-Ninth street, New York, December 2 to 5, inclusive. At the Railroad Division sessions the following papers will be presented:

Tuesday, December 3
9:30 a.m.

Measurement of Steam Rate and Indicated Horsepower of Locomotives, by Arthur Williams

Railroad Mechanical Engineering (Progress report)

2 p.m.

Locomotive and Car Journal Lubrication, by E. S. Pearce

Wednesday, December 4
(Locomotive Session)
2 p.m.

Lateral Oscillations of Rail Vehicles, by H. F. Langer and J. P. Shamberger

Safety of High-Speed Locomotives, by B. S. Cain

Other sessions of general interest are:

Wednesday, December 4
2 p.m.
Boiler Furnace Session

An Experimental Investigation of Heat Absorption in Boiler Furnace, by W. J. Wholenberg, H. F. Mullikin, W. H. Armacost and C. W. Gordon

Critical Review of Methods of Computing Heat Absorption in Boiler Furnaces in the light of data Presented in Part I, by W. J. Wohlenberg and H. F. Mullikin

An Empirical Method of Solving for Heat Absorption in Boiler Furnaces, by H. F. Mullikin

Thursday, December 5
2 p.m.
Oil and Gas Power Session

Film Lubrication Theory and Engine Bearing Design, by E. S. Dennison

Ignition and Combustion of Diesel Fuels, by G. D. Boerlage and J. J. Broeze

Oil Engine Electric Generating Station Operating Costs, by Geo. C. Eaton

Boiler Feedwater Session

The Use of Solubility Data to Control the Deposition of Sodium Sulphate or Its Complex Salts in Boiler Water, by W. C. Schroeder, A. A. Berk and E. Partridge

Estimation of Dissolved Solids in Boiler Water by Density Readings, by J. A. Holmes and J. K. Rummel

Suspended Solids in Foaming and Priming of Boiler Water, by C. W. Foulk

Effect of Solutions on Endurand of Low Carbon Steel Under Repeated Torsion at 482 deg. F. (250 deg. C.), by W. C. Schroeder and Everett P. Partridge

Embrittlement of Boiler Steel by Caustic Soda, by G. H. Wagner and J. R. Wall

Study of Effect of Concentrated Sodium Hydroxide on Boiler Steel Under Tension, by A. S. Perry

Radiation from Non-Luminous Flames, by H. C. Hottel and V. C. Smith

For explanation see page 486

Directory

The following list gives names of secretaries, dates of next regular meetings and places of meetings of mechanical associations and railroad clubs:

American Society of Mechanical Engineers.—C. E. Davies, 29 West Thirty-ninth street, New York.

Railroad Division.—Marion B. Richardson, 192 East Cedar street, Livingston, N. J.

Machine Shop Practice Division.—G. F. Nordenholt, 330 West Forty-second street, New York.

Materials Handling Division. — M. W. Potts, Alvey-Ferguson Company, 1440 Broadway, New York.

Oil and Gas Power Division. — M. J. Reed, 2 West Forty-fifth street, New York.

Fuels Division.—W. G. Christy, Department of Health Regulation, Court House, Jersey City, N. J.

Canadian Railway Club. — C. R. Crook, 2271 Wilson avenue, Montreal, Que. Regular meetings, second Monday of each month, except in June, July and August, at Windsor Hotel, Montreal, Que.

Car Foremen's Association of Chicago.—G. K. Oliver, 2514 West Fifty-fifth street, Chicago. Regular meetings, second Monday in each month, except June, July and August, La Salle Hotel, Chicago, Ill.

Car Foremen's Association of Omaha, Council Bluffs and South Omaha Interchange.—J. R. Leach, car department, Chicago Great Western, Council Bluffs, Ia. Regular meetings, second Thursday of each month at 1:15 p.m. at Union Pacific shops, Council Bluffs.

Central Railway Club of Buffalo.—Mrs. M. D. Reed, Room 1817, Hotel Statler, Buffalo, N. Y. Regular meetings, second Thursday each month, except June, July and August, at Hotel Statler, Buffalo.

Eastern Car Foremen's Association. — E. L. Brown, care of the Baltimore & Ohio, St. George, Staten Island, N. Y. Regular meetings, fourth Friday of each month, except June, July, August and September.

Indianapolis Car Inspection Association. — R. A. Singleton, 822 Big Four Building, Indianapolis, Ind. Regular meetings, first Monday of each month, except July, August and September, at Hotel Severin, Indianapolis, at 7 p. m.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic avenue, Boston, Mass. Regular meetings, second Tuesday in each month, excepting June, July, August and September, at Copley-Plaza Hotel, Boston.

New York Railroad Club.—D. W. Pye, Room 527, 30 Church street, New York. Meetings, third Friday in each month, except June, July and August, at 29 West Thirty-ninth street, New York.

Northwest Car Men's Association. — E. N. Myers, chief interchange inspector, Minnesota Transfer Railway, St. Paul, Minn. Meetings, first Monday each month, except June, July and August, at Minnesota Transfer Y. M. C. A. Gymnasium Building, St. Paul.

Pacific Railway Club.—William S. Wollner, P. O. Box 3275, San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately—June, in Los Angeles and October, in Sacramento.

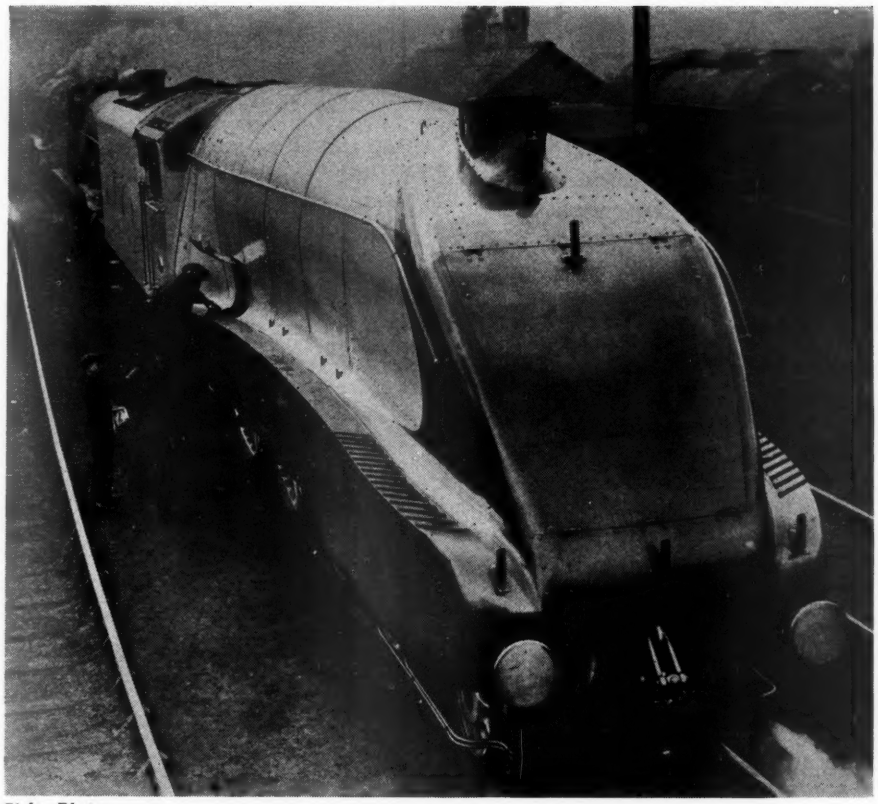
Railway Club of Greenville. — Ralph D. Stewart, 21 Sherrard avenue, Greenville, Pa. Regular meetings, third Thursday in month, except June, July and August.

Railway Club of Pittsburgh.—J. D. Conway, 1941 Oliver Building, Pittsburgh, Pa. Regular meetings, fourth Thursday in month, except June, July and August, Fort Pitt Hotel, Pittsburgh, Pa.

Southern and Southwestern Railway Club.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings, third Thursday in January, March, May, July and September. Annual meeting, third Thursday in November, Ansley Hotel, Atlanta, Ga.

Toronto Railway Club.—R. H. Burgess, Box 8, Terminal A, Toronto, Ont. Meetings, fourth Monday of each month, except June, July and August.

Western Railway Club.—C. L. Emerson, 822 Straus Building, Chicago. Regular meetings, third Monday in each month, except June, July, August and September.



Globe Photo

The Silver Link, streamlined steam locomotive on the London & North Eastern's Silver Jubilee train

NEWS

THE READING is building 100 automobile box car bodies of 50 tons' capacity in its shops at Reading, Pa.

THE ATCHISON, TOPEKA & SANTA FE has ordered two light-weight chair cars for experimental purposes. The cars, one of which will be built by the St. Louis Car Company of Cor-Ten steel and the other of stainless steel by the Edward G. Budd Manufacturing Company, will each seat 65 persons.

THE PENNSYLVANIA is planning to build 10,000 freight cars of various types and to convert 1,000 additional cars at a cost of approximately $30,000,000.

THE CHICAGO, BURLINGTON & QUINCY is considering the purchase of a fourth car for each of its Twin Zephyrs. The Burlington has authorized a $3,000,000 equipment replacement program which provides for the construction of three 4-8-4 type locomotives, 500 steel underframe box cars and 750 open-top cars.

THE CANADIAN PACIFIC has given orders to the National Steel Car Company, Hamilton, Ont., for the frames of eight 65-ft. steel coaches and of four combination baggage and buffet cars, and for four complete steel mail and express cars, and to the Montreal Locomotive Works for five 4-4-4 type locomotives.

British Streamlined Steam Train Averages 70.4 M.P.H. for 232 Miles

THE London & North Eastern of Great Britain introduced on September 30 its new streamlined steam train—the Silver Jubilee—which is scheduled to make the 268-mi. run between King's Cross (London) and Newcastle, with a stop at Darlington, in four hours. The average rate of speed for the entire run in each direction is 67.07 m.p.h. but the 232-mile run between King's Cross and Darlington is covered in 198 min. or at 70.4 m.p.h., which the Railway Gazette (London) calls "the fastest scheduled start-to-stop run in the world for a distance of over 200-miles."

Newspaper dispatches from London on September 28 stated that the Silver Jubilee, on its September 27 trial run from King's Cross to Grantham, attained a maximum speed of 112 m.p.h. and covered this 105.5-mile run at an average speed of 104.9 m.p.h.

The Silver Jubilee, so named to commemorate the twenty-fifth year of King George's reign, consists of a streamlined steam locomotive (the Silver Link) and three articulated units—one with three body sections and the others with two each. One of the two-body units houses the accommodations for first-class passengers while the other houses the accommodations for third-class passengers. The three-body unit, placed in the center of the train, includes a first class dining car, a kitchen car and a third class diner.

Mechanical Division Letter-Ballot Returns

AT the business session of the Association of American Railroads, Mechanical Division, held at Chicago June 26 and 27, recommended changes in the standard practice of the division were made by eight standing committees, including the following: Arbitration, Brakes and Brake Equipment, Car Construction, Couplers and Draft Gears, Loading Rules, Specifications for Materials, Tank Cars, and Wheels. A total of 61 specific propositions were ordered submitted to letter-ballot, and recently compiled returns show that all of these propositions to ammend the standard and recommended practice of the division have been approved, effective March 1, 1936, with the exception of proposition 20 (a) to 20 (i), inclusive, and 56, covering definitions and designating letters in the classification of cars, which are approved to be effective immediately, and of the propositions to amend the interchange rules of the division, effective January 1, 1936.

Supply Trade Notes

ROGER Q. MILNES and S. C. Johnson have become assistants to vice-president of the Dearborn Chemical Company, Chicago.

W. J. GEORGE has been appointed assistant sales manager of the Edgewater Steel Company, Pittsburgh, Pa. Mr. George has been with this company for over 18 years and his experience covers both the operating and sales departments.

MUSCOE BURNETT, JR., formerly assistant division manager of the Linde Air Products Company, at Chicago, has been appointed assistant sales manager of the Oxweld Railroad Service Company, with headquarters at Chicago.

H. D. RICHARDSON has been appointed special sales representative of the Ralston Steel Car Company, Columbus, Ohio. Mr. Richardson was a member of the class of 1917, Purdue University, and formerly served with the American Steel Foundries.

F. C. BRANDT of the Chicago office of the Babcock & Wilcox Company, New York, is now in charge of a new sales office to serve the eastern half of Missouri and the southern section of Illinois, which the company has opened at 1809 Railway Exchange building, St. Louis, Mo.

G. N. VAN SWERINGEN, assistant to the president of the Chicago Railway Equipment Company, Chicago, has been elected vice-president of sales, succeeding F. T. DeLong, deceased. F. R. Carlson, assistant to vice-president of sales, has been appointed manager of sales.

THE REPUBLIC STEEL CORPORATION, Youngstown, Ohio, has moved its Pittsburgh district sales office from Fourth and Bingham streets to 1832 Oliver building, Pittsburgh, Pa. The Union Drawn Steel Company, a Republic subsidiary, has moved into an adjoining suite in the Oliver building.

THE SUPERHEATER COMPANY, New York, celebrates this year the twenty-fifth anniversary of the manufacture of the first Elesco locomotive steam superheater. Since that time the use of Elesco superheaters has been extended to include marine boilers and stationary boilers for industrial plants. In addition to superheaters, locomotive feedwater heaters, exhaust steam injectors, pyrometers, air preheaters and other heat exchangers are now manufactured.

I. LAMONT HUGHES, formerly president of Carnegie Steel Company, has been appointed executive vice-president of the Carnegie-Illinois Steel Corporation; C. V. McKaig, formerly vice-president and general manager of sales of Carnegie, has been appointed vice-president and general manager of sales, and J. E. Lose, formerly vice-president of Carnegie, is vice-president in charge of operations. All these officers will maintain offices in both Pittsburgh, Pa., and Chicago. G. Cook Kimball, formerly vice-president of Illinois Steel Company, is vice-president and chief executive of the Chicago district of the Carnegie-Illinois Steel Corporation; William I. Howland, Jr., formerly vice-president and general manager of sales of Illinois, is vice-president in charge of western sales, both with offices in Chicago; L. H. Burnett, formerly vice-president of Carnegie, is vice-president at Pittsburgh; and Carroll Burton, formerly president of the Lorain Steel Company, Johnstown, Pa., is vice-president in charge of the Lorain division. J. W. Hamilton, formerly secretary of Carnegie, is secretary; William Donald, formerly auditor and assistant secretary of Carnegie, is auditor; and H. E. Jeffries, formerly treasurer of Carnegie, is treasurer.

I. Lamont Hughes was born at Mercer, Pa., in January, 1878, and was educated in the common and high schools. He began work in the engineering department of the Edgar Thomson Works of the Carnegie Steel Company in September, 1897. He was then consecutively in charge of engineering for the Union Steel Company, later part of the American Steel & Wire Company; master mechanic of the bar mills of the Youngstown district of the Carnegie Steel Company; assistant general superintendent of those mills, and later general superintendent of the same mills. In 1916

I. Lamont Hughes

he was appointed assistant general superintendent of the entire Youngstown district of the Carnegie Steel Company. He subsequently served as general superintendent in charge of the Canadian Steel Company's plant at Ojibway, Ontario, and in June, 1918, went to the Neville Island gun plant at Neville Island, Pa., as general superintendent of the operations being carried out by the United States Steel Corporation for the government. In 1919 Mr. Hughes became president of the Lorain Steel Company, a subsidiary of the United States Steel Corporation, returning to the Carnegie Steel Company, Youngstown, as general superintendent in January, 1920. Five years later he became vice-president of that company and from April, 1928, served as a vice-president of the United States Steel Corporation. In August, 1930, he was elected president of the Carnegie Steel Company.

C. V. McKaig was born at Pittsburgh and was educated in the public schools, later completing classical and scientific courses at Princeton University. Mr. McKaig entered the steel business with the old Park Works of the Crucible Steel Company, Pittsburgh, working through a number of departments until he became

C. V. McKaig

superintendent of the bar mills. In 1908 he joined the Carnegie Steel Company and in April, 1929, became general manager of the bar and hoop production, including design, engineering and marketing of all special bar mill products. When the Great Lakes Steel Corporation, Detroit, Mich., began operations later in 1929, Mr. McKaig became its vice-president in charge of sales, leaving that position in June, 1932, to return to the Carnegie Steel Company as vice-president and general manager of sales.

Obituary

WILLIAM DOWNS, eastern sales manager and engineer of tests of the Burden Iron Company, Troy, N. Y., died suddenly at his home in Troy on September 28, at the age of 61. Mr. Downs had been in continuous service with the Burden Iron Company for 43 years.

FREDERIC T. DELONG, vice-president in charge of sales of the Chicago Railway Equipment Company, Chicago, died at Jackson, Wyo., on September 28, following a week's illness. Mr. DeLong was born at Utica, N. Y., and began his business career in a clerical position in Utica. After holding various positions with other companies, he was appointed general manager of the Buhl Malleable Company, Detroit, Mich. In 1905 he entered the employ of the Chicago Railway Equipment Company as second vice-president and sales manager, and in 1930 was appointed vice-president in charge of sales.

FRANK A. HATCH, president of Shepard Niles Crane & Hoist Corporation, Montour Falls, N. Y., died at his home in Mon-

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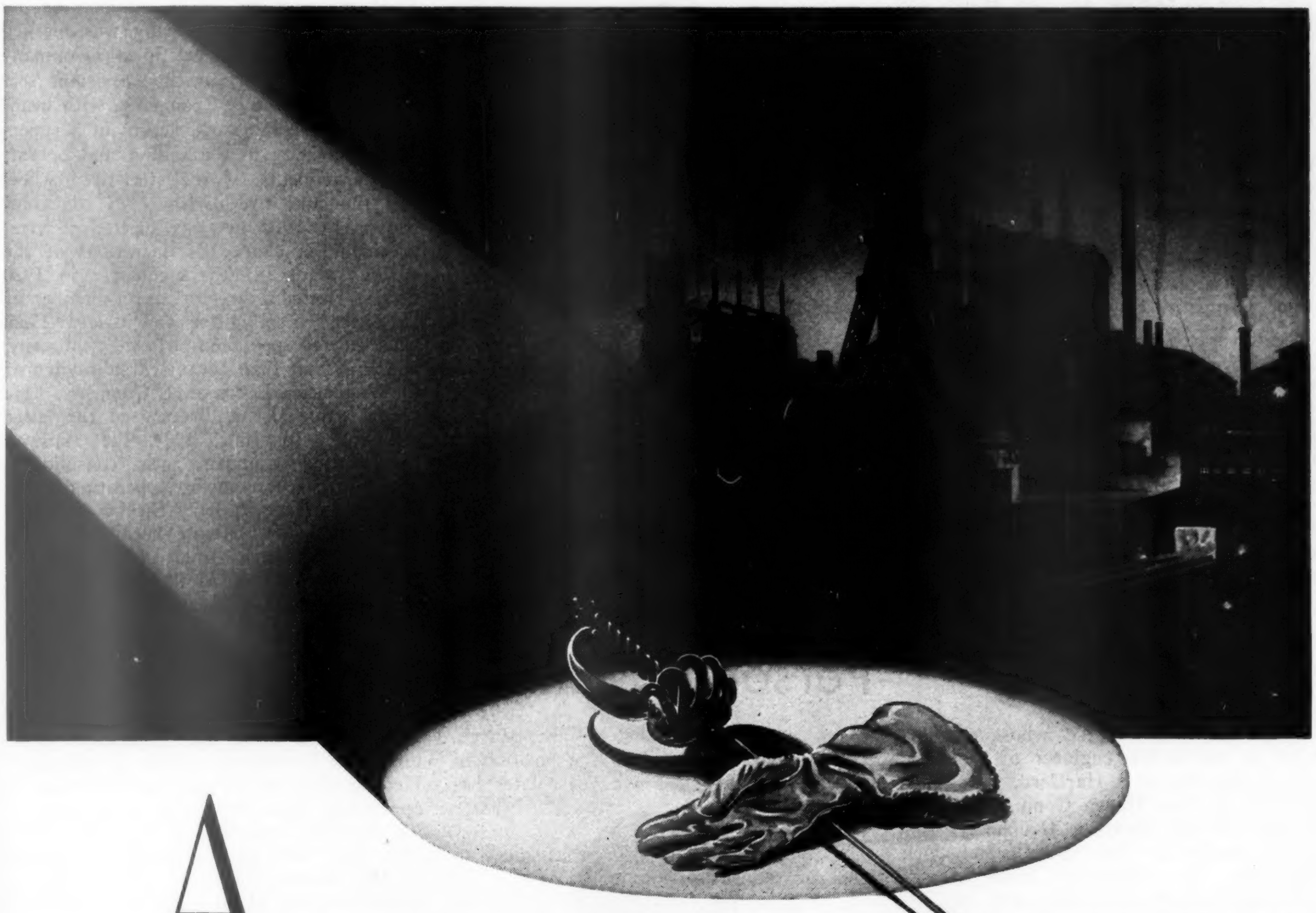

tour Falls on October 15. Mr. Hatch was born in November, 1877, at Bay City, Mich., and was a graduate of the University of Michigan in 1900. Three years later he served as treasurer of the Pneumatic Tool Company at Montour Falls, in 1917 becoming vice-president and general manager of its successor, the Shepard Electric Crane & Hoist Company. In 1929 he was elected president and a member of the executive committee of the Shepard Niles Crane & Hoist Corporation. He was also a director of the Niles-Bement-Pond Company, New York.

Alexander S. Henry, vice-president and a director of the American Locomotive Company, died on October 10. Mr. Henry was born in Manchester, England, and came to this country when a young man. His early experience in the iron and steel business was obtained among the steel mills in the Cleveland district and vicinity, where he served in various capacities, principally in the open-hearth departments. He later entered the employ of one of the steel-tired wheel plants in Cleveland which subsequently became a part of the Steel-Tired Wheel Company, and during its existence he was in charge of the local management of a number of its plants. When this company was merged with the Railway Steel-Spring Company in 1902 Mr. Henry became assistant secretary of the merged company, with headquarters at New York, acting in a supervisory capacity in the selling and operating departments of the steel-tired wheel and the steel tire divisions of the company. In 1910 he was elected a vice-president, in charge of operations of the various plants of the company; in 1920 he was elected a director and a member of the executive committee, and in May, 1926, was elected president of the company, which at that time became a subsidiary of the American Locomotive Company. He then became also a director of the latter company. In June, 1934, the Railway Steel-Spring Company was consolidated with the parent company, operating under the name of the Railway Steel-Spring Division, and Mr. Henry became a vice-president of the American Locomotive Company, in charge of the Railway Steel-Spring Division.

Alexander S. Henry

Personal Mention

Kenneth Cartwright, whose appointment as mechanical engineer of the New York, New Haven & Hartford, with headquarters at New Haven Conn., was noted in the October *Railway Mechanical Engineer,* spent two years in industrial work following his graduation from Massachusetts Institute of Technology. He entered the service of the New Haven in 1914 as a material inspector. In 1918 he accepted a naval commission, and on his return from this service to the New Haven he became assistant to engineer of tests. Mr. Cartwright was appointed general mechanical inspector in 1923, and assistant mechanical engineer in June, 1925.

Kenneth Cartwright

David P. Carey, who has been appointed assistant general mechanical superintendent of the New York, New Haven & Hartford, with headquarters at Readville, Mass., entered the service of the New Haven in 1901 as a machinist apprentice at the Norwood, Mass., shops. He was appointed foreman in May, 1912, at the Roxbury, Mass., shop, later being transferred to the position foreman at the Dover street enginehouse, Boston. In March, 1918, he was promoted to the position of general foreman, and five years later became acting master mechanic at Taunton, Mass. Mr. Carey was appointed master mechanic of the Midland division in October, 1923, and in February, 1929, became superintendent of shops at Readville.

David P. Carey

George William Rink, mechanical engineer of the Central of New Jersey at Elizabethport, N. J., has been appointed mechanical engineer of the Central of New Jersey and the Reading, with headquarters at Reading, Pa. Mr. Rink, who was born on September 4, 1875, at New York, is a graduate of Cooper Union, New York. He entered the employ of the Erie on May 14, 1892, serving until March, 1896, as a machinist apprentice, and until 1899 as a machinist and shop draftsman. During 1899-1900 he was a draftsman on the Northern Pacific. He then served (1900-01) as a draftsman on the Central of New Jersey, becoming enginehouse foreman and inspector of new equipment in 1901. During 1902-03 he was engaged in road testing of locomotives and as a draftsman. He was chief draftsman and instructor of apprentices from 1903 until 1909, when he was appointed mechanical engineer. From 1918 until 1929 he was assistant superintendent motive power, in charge also of engineering, at Jersey City, N. J. In 1929 he was appointed mechanical engineer at Elizabethport.

John C. Hassett who has been appointed assistant to general mechanical engineer of the New York, New Haven & Hartford, as noted in the October issue, was born on May 21, 1882, at Susquehanna, Pa., and was educated at Laurel Hill Academy. He entered railway service in August, 1898, as clerk in the mechanical engineer's office of the Erie, serving consecutively as machinist apprentice, draftsman, and technical instructor of apprentices for that road. In 1910 he became a draftsman for the Union Pacific and in 1911 went with the Baltimore & Ohio as a draftsman. Mr.

J. C. Hassett

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Hassett entered the service of the New Haven in 1911 as a draftsman and the following year became chief draftsman. In September, 1918, he was appointed mechanical engineer.

Master Mechanics and Road Foremen

A. J. FLOWERS, master mechanic of the Central of Georgia at Macon, Ga., has been transferred to Savannah, Ga., where he will be in charge of company shops.

T. A. JOHNSON, electrical engineer of the Central of Georgia, with headquarters at Savannah, has been appointed master mechanic at Macon, Ga. Mr. Johnson also continues supervision over electrical engineering work.

Shop and Enginehouse

JOHN W. O'MEARA, who has been appointed superintendent of shops of the New York, New Haven & Hartford at Readville, Mass., as noted in the October *Railway Mechanical Engineer,* was born

J. W. O'Meara

on August 28, 1875, at New Haven, Conn. He attended both public and high schools, from June, 1892, to December, 1894, was a toolmaker apprentice in the employ of the American Fish Hook Company. On February 18, 1895, he became a machinist's helper on the New Haven; in June, 1898, a machinist, and on September 1, 1904, foreman machinist. He was appointed assistant general foreman at the Van Nest (N. Y.) shops in September, 1913; general foreman at Readville on September 1, 1917; shop superintendent at New Haven, on August 23, 1923, and shop superintendent at Van Nest on November 1, 1931.

Purchasing and Stores

E. M. WILLIS, executive assistant on the Northern Pacific, has been appointed purchasing agent, with headquarters at St. Paul, succeeding C. C. Kyle, deceased.

GEORGE W. HIGDON, storekeeper of the Gulf Coast Lines at Palestine, Tex., has been promoted to the position of division storekeeper at Kingsville, Tex., to succeed Sam P. Warmack.

SAM P. WARMACK, division storekeeper on the Gulf Coast Lines (a unit of the Missouri Pacific Lines), with headquarters at Kingsville, Tex., has been appointed general storekeeper of the Missouri Pacific Lines in Texas and Louisiana, succeeding the late R. D. Crawford. Mr. Warmack was born on November 25, 1892, at Beaverdale, Ga. He entered railway service on October 1, 1912, with the San Antonio, Uvalde & Gulf (also a unit of the Missouri Pacific Lines). Three years later he went with the El Paso Electric Railway Company. On August 16, 1916, he entered the service of the International Great Northern, where he served in the mechanical department at Taylor, Tex., until April 26, 1917 when he was transferred to the store department. On February 4, 1920, he was promoted to division storekeeper of the Fort Worth division, at Mart, Tex., and on May 10, 1923, was appointed general foreman of stores, with headquarters at Palestine, Tex. On June 1, 1924, he returned to Taylor as storekeeper and in May, 1926 was appointed joint storekeeper for the Houston Belt & Terminal and the International Great Northern, with headquarters at Houston, Tex. On February 15, 1928, Mr. Warmack was promoted to the position of division storekeeper of the St. Louis, Brownsville & Mexico (another unit of the Missouri Pacific Lines), with headquarters at Kingsville.

Samuel P. Warmack

Obituary

C. C. KYLE, purchasing agent of the Northern Pacific, at St. Paul, Minn., died on September 22, at Tacoma, Wash.

ADAM JOHNSON POOLE, who retired in 1933 as mechanical assistant to the president of the Tennessee Central, died at Knoxville, Tenn., on October 4. Mr. Poole was born at Americus, Ga., 62 years ago. At the age of sixteen be entered railroad service as a machinist apprentice with the Central of Georgia at Macon, Ga. After completing his apprenticeship and while working as a machinist he worked as an extra fireman and later went to the Seaboard Air Line as locomotive engineer, serving successively as general foreman at Americus, master mechanic, general master mechanic and superintendent of motive power. Leaving railroad service, Mr. Poole engaged in private business in Norfolk, Va., and in 1915 he was employed by the Galena-Signal Oil Company as a mechanical expert. He continued with this company until 1927, when he returned to railway service as mechanical assistant to the president of the Tennessee Central.

MARINAC'S RAIL ODDITIES

MARINAC has furnished us with the following explanation of the three cartoons which appear elsewhere in this issue:

Page 454. It so happens that a small river runs near the little town of Tamasopo, located between Cardenas and Las Palmas on the Mexico City, San Luis Potosi and Tampico division of the National Railways of Mexico. This river flows through a small natural rock arch formed by the prolonged solution and abstraction of mineral matter. One may visit this freak of nature by getting off the train at a flag station by the name of "El Cafetal" and walking about 500 meters to the natural arch.

Page 469. For the first time in aviation history an army dirigible successfully landed mail on the roof of a speeding train in November, 1928. Army officers maneuvered a 200-ft. non-rigid ship down over the top of a mail car roof after a chase of 35 miles. In spite of the speed of the train, the dirigible maintained its position long enough to permit the transfer of a sack of mail, and to demonstrate the possibility of air-to-land transfer. Cameras were carried and moving pictures were taken. During the chase the dirigible traveled at the high rate of speed directly above the train tracks. On one side of the tracks were strung telephone wires, while on the other ran high tension power lines. The airship traveled between these electric walls and almost came to grief when one of the trailing cables swept a high tension line. In spite of the air currents set up by the train, the dirigible finally managed to catch the train and drift above it.

Page 482. The "Senator's Special Railroad," that's the name that should be given to the monorail line with two cars that runs through the tunnel connecting the Capitol and the Senate Office Building in Washington, D. C. It is used by our senators in their travels between these two buildings. To walk from the Capitol to either the Senate or House of Representatives building requires from three to five minutes, depending on what part of the Capitol you set out for. The miniature train makes its run in from one to two minutes. The motorman does not complain of being overburdened with traffic. A similar tunnel connects the House Office Building with the Capitol, but one of these tiny transportation systems has never been installed here; the representatives prefer to walk. Perhaps it is because they are usually younger than their brother lawmakers, and so take more kindly to the exercise.